User Manual

Allen-Bradley

Guardmaster® 440C-CR30 Configurable Safety Relay

Catalog Number 440C-CR30-22BBB

Allen-Bradley • Rockwell Software

Rockwell Automation

Important User Information

Read this document and the documents listed in the additional resources section about installation, configuration, and operation of this equipment before you install, configure, operate, or maintain this product. Users are required to familiarize themselves with installation and wiring instructions in addition to requirements of all applicable codes, laws, and standards.

Activities including installation, adjustments, putting into service, use, assembly, disassembly, and maintenance are required to be carried out by suitably trained personnel in accordance with applicable code of practice.

If this equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

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The examples and diagrams in this manual are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular installation, Rockwell Automation, Inc. cannot assume responsibility or liability for actual use based on the examples and diagrams.

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Throughout this manual, when necessary, we use notes to make you aware of safety considerations.

	WARNING: Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death, property damage, or economic loss.
	ATTENTION: Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss. Attentions help you identify a hazard, avoid a hazard, and recognize the consequence.
IMPORTANT	Identifies information that is critical for successful application and understanding of the product.

Labels may also be on or inside the equipment to provide specific precautions.

	SHOCK HAZARD: Labels may be on or inside the equipment, for example, a drive or motor, to alert people that dangerous voltage may be present.
	BURN HAZARD: Labels may be on or inside the equipment, for example, a drive or motor, to alert people that surfaces may reach dangerous temperatures.
	ARC FLASH HAZARD: Labels may be on or inside the equipment, for example, a motor control center, to alert people to potential Arc Flash. Arc Flash will cause severe injury or death. Wear proper Personal Protective Equipment (PPE). Follow ALL Regulatory requirements for safe work practices and for Personal Protective Equipment (PPE).

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Read this preface to familiarize yourself with the rest of the manual. It provides information concerning:

- who should use this manual
- the purpose of this manual
- related documentation
- conventions used in this manual

Who Should Use this Manual

Use this manual if you are responsible for designing, installing, programming, or troubleshooting control systems that use the CR30 safety relay.

You should have a basic understanding of electrical circuitry and familiarity with safety related control systems. If you do not, obtain the proper training before using this product.

Purpose of this Manual

This manual is a reference guide for the CR30 safety relay, plug-in modules and accessories. It describes the procedures you use to install, wire, and troubleshoot your relay. This manual:

- explains how to install and wire your relay
- gives an overview of the CR30 safety relay system

Refer to the Online Help provided with Connected Components Workbench™ software for more information on programming your CR30 safety relay.

Additional Resources

These documents contain additional information concerning related products from Rockwell Automation.

Resource	Description
2711C-UM001_-EN-P	PanelView User Manual
440C-QS001_-EN-P	CR30 With Modbus to PanelView Quick Start
Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1	Provides general guidelines for installing a Rockwell Automation industrial system.
Product Certifications website, http://www.ab.com	Provides declarations of conformity, certificates, and other certification details.
Allen-Bradley Industrial Automation Glossary, AG-7.1	A glossary of industrial automation terms and abbreviations.

You can view or download publications at http:/www.rockwellautomation.com/literature/. To order paper copies of technical documentation, contact your local Allen-Bradley distributor or Rockwell Automation sales representative.

You can download the latest version of Connected Components Workbench for your CR30 at http://compatibility.rockwellautomation.com/Pages/MultiProductDownload.aspx?Keyword=Free&crumb=112

Definitions

Publication AG-7.1 contains a glossary of terms and abbreviations used by Rockwell Automation to describe industrial automation systems. Below is a list of specific terms and abbreviations used in this manual.

- **CCW** – The Connected Components Workbench. This is a software package that allows the user to configure a CR30, program a Micro 800 controller and configure a PanelView™ HMI.
- **CR30** – Is the Cat. No. 440R-CR30-22BBB software configurable safety relay, described in this user manual.
- **HI** – Logic state of being ON.
- **LO** – Logic state of being OFF.
- **Logic Block** – On the CCW grid, a logic block resides in any of the four columns. A logic block is either: 1) a Safety Monitoring Function, 2) Logic Level A, 3) Logic Level B, or 4) Safety Output Function.
- **Logic Level A (LLA)** – This column is used to perform logic processes on a number of inputs to create a desired output state.
- **Logic Level B (LLB)** - This column is used to perform logic processes on a number of inputs to create a desired output state.
- **N.C. (Normally Closed)** – An electrical contact whose normal state (i.e., no pressure or electrical potential applied) is in the closed position.
- **N.O. (Normally Open)** – An electrical contact whose normal state (i.e., no pressure or electrical potential applied) is in the open position.
- **OSSD (Output Signal Switching Device)** – This is typically a pair of solid state signals that are pulled up to the DC source supply. The signals are usually tested for short circuits to the DC power supply, short circuits to the DC common and shorts circuits between the two signals.
- **Reaction Time** - Describes the time between the true states of one input to the ON state of the output.
- **Recovery Time** - Describes the time required for the input to be in the LO state before returning to the HI state.
- **Response Time** - Describes the time between the trigger of one input to the OFF state of the output.
- **Safety Function** – This describes the complete sensing of the action (e.g. open a safety gate) to execution the final output device (e.g. turning off a pair of contactors).
- **Safety Monitoring Function (SMF)** – This is the input block on the Connected Components Workbench for the CR30.
- **Safety Output Function (SOF)** – This is the output block on the Connected Components Workbench for the CR30.
- **Single Wire Safety (SWS)** – This is a unique, safety rated signal sent over one wire to indicate a safety status. The SWS can be used in Category 4, Performance Level e, per ISO 13849-1 and Safety Integrity Level (SIL) 3, per IEC 62061 and IEC 61508.

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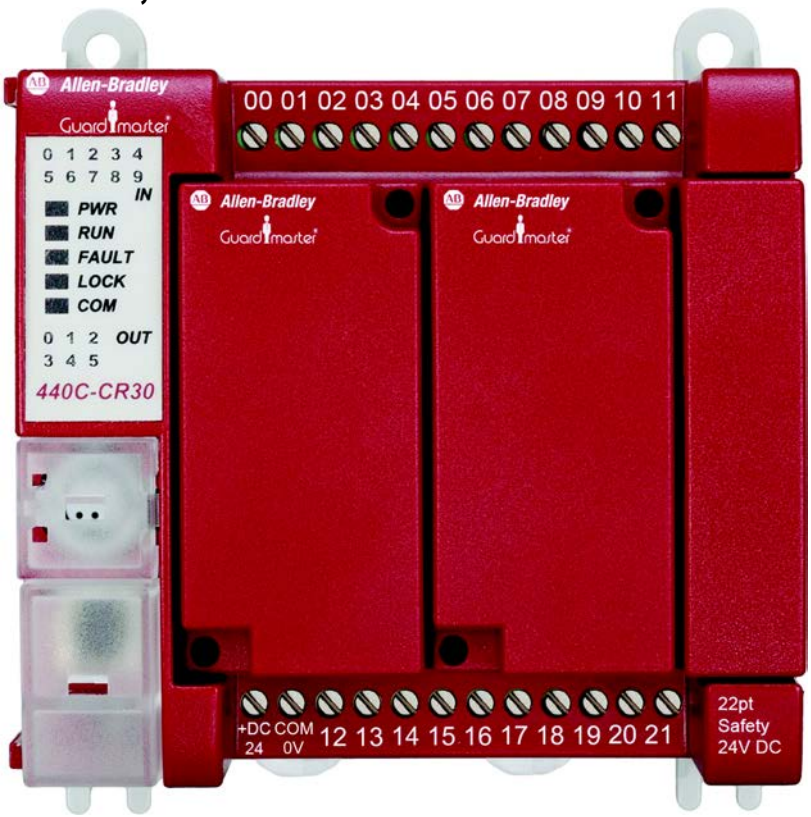
Overview

Hardware Features

Figure 1 - CR30 Relay



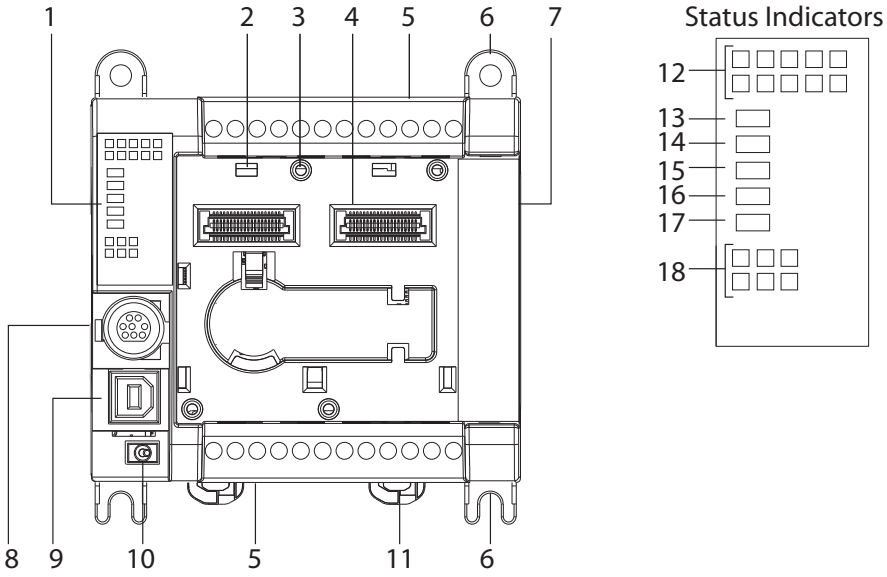
The Cat. No. 440C-CR30-22BBB (CR30) relay is a software configurable safety relay. The CR30 has 22 embedded safety rated inputs and outputs and accepts up to two plug-in modules, each of which has four standard inputs and four standard outputs. The CR30 must be configured using a personal computer (PC) running the Allen-Bradley Connected Components Workbench (CCW).

The CR30 is based on the Micro 800 platform. The housing is red to signify it as a safety device and to distinguish it from the grey-colored standard controllers.

The CR30 can be configured to accept two single wire safety inputs and to provide two single wire safety outputs. This feature allows the CR30 to be an integral part of an extensive machine safeguarding system.

CR30 Hardware Details

Figure 2 - Hardware Details



	Description
1	Status indicators
2	Plug-in latch
3	Plug-in screw hole
4	40-pin high speed plug-in connector
5	I/O & Power terminal blocks
6	Mounting screw hole/mounting foot
7	Right-side cover
8	RS232 non-isolated serial port
9	Type B connector USB

	Description
10	Verification button
11	Din Rail mounting latch
12	Input status
13	Power status
14	Run status
15	Fault status
16	Lock status
17	Serial communications status
18	Output status

Max Number of Inputs and Outputs

Many of the inputs and outputs can be configured for different roles. The table below shows the maximum number of terminals for a specific function. Assigning a configurable terminal to one role will eliminate its use as a different role and reduce the allowed maximum number of terminals for other functions.

Function	Max Allowed
Safety inputs, normally closed	up to 18
Safety inputs, normally open	up to 6
Single wire safety input	up to 2
Single wire safety output	up to 2

Function	Max Allowed
Pulse test outputs	up to 6
OSSD safety outputs	up to 10
Non-pulsed (standard) outputs	up to 6

Software

The CR30 is software configurable using the Rockwell Automation Connected Components Workbench (CCW). Connected Components Workbench is a set of collaborative tools supporting the CR30 safety relays. CCW is based on Rockwell Automation and Microsoft Visual Studio technology. The CCW is used to configure the CR30, program the Micro 800 controllers, and configure many PowerFlex drives and PanelView graphic display terminals.

Obtain Connected Components Workbench

The Connected Components Workbench is free and can be downloaded from: http://compatibility.rockwellautomation.com/Pages/MultiProductDownload.aspx?Keyword=Free&crumb=112

To help you configure your relay through the Connected Components Workbench software, you can refer to the Connected Components Workbench Online Help (provided with the software).

USB Connection

The CR30 has a USB interface for connection to a personal computer for configuration. Use a standard USB A Male to B Male cable for connecting to the relay.

Serial Port Connection

The embedded serial port is used to transfer control and status to other Allen-Bradley products. The CR30 only supports RS232 protocol. The connection is not isolated. The RS232 signals are referenced to the relay power ground.

Notes:

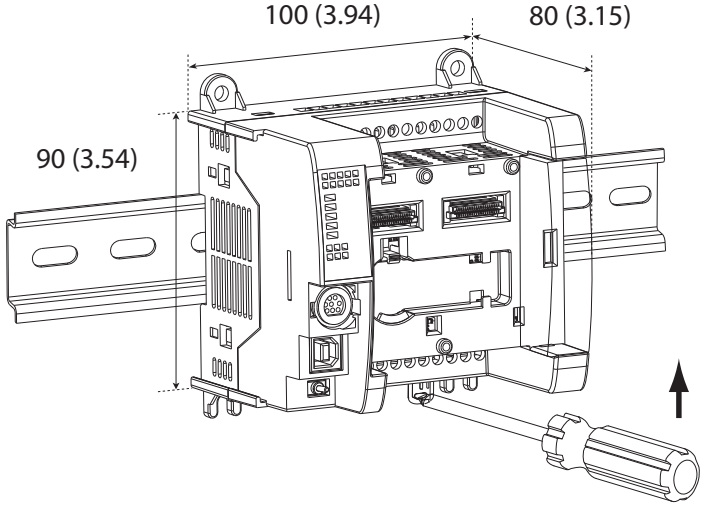
Installation

Mounting Dimensions

DIN Rail Mounting

Mounting dimensions do not include mounting feet or DIN Rail latches.

Figure 3 - DIN Rail Mounting [mm (in.)]



Maintain spacing from objects such as enclosure walls, wireways and adjacent equipment. Allow 50.8 mm (2 in.) of space on all sides for adequate ventilation. If optional accessories/modules are attached to the relay, such as the power supply Cat. No. 2080-PS120-240VAC, make sure that there is 50.8 mm (2 in.) of space on all sides after attaching the optional parts.

The module can be mounted using the following DIN Rails:
35 x 7.5 x 1 mm (EN 50 022 - 35 x 7.5).

To mount the module on a DIN Rail:

1. Use a flat-blade screwdriver in the DIN Rail latch and pry it downwards until it is in the unlatched position.
2. Hook the top of the DIN Rail mounting area of the relay onto the DIN Rail, and then press the bottom until the relay snaps onto the DIN Rail.
3. Push the DIN Rail latch back into the latched position.

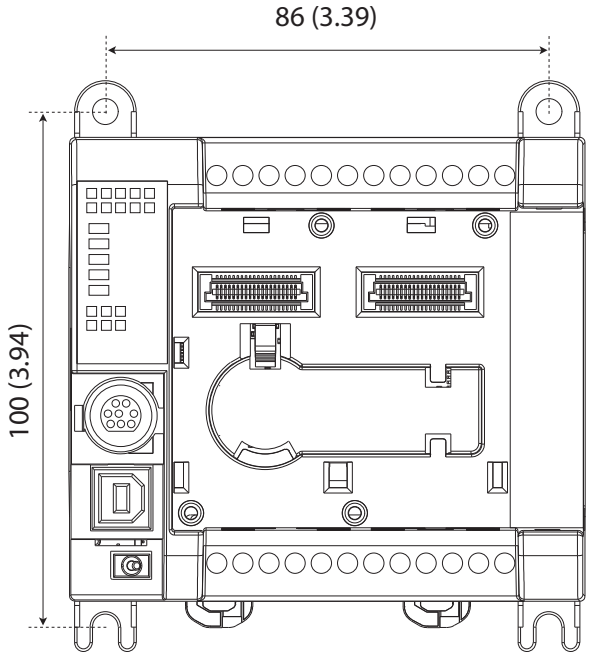
Use DIN Rail end anchors (Allen-Bradley Cat. Nos. 1492-EAJ35 or 1492-EAHJ35) for vibration or shock environments.

To remove the module from the DIN Rail, pry the DIN Rail latch downwards until it is in the unlatched position.

For environments with greater vibration and shock concerns, use the panel mounting method, instead of DIN Rail mounting.

Panel Mounting

Figure 4 - Panel Mounting [mm (in.)]



The preferred mounting method is to use four M4 (#8) screws per module. Hole spacing tolerance: ±0.4 mm (0.016 in.).

Follow these steps to install your relay using mounting screws.

1. Place the relay against the panel where you are mounting it. Make sure the relay is spaced properly.
2. Mark drilling holes through the mounting screw holes and mounting feet then remove the relay.
3. Drill the holes at the markings, then replace the relay and mount it.

Leave the protective debris strip in place until you are finished wiring the relay and any other devices.

Enclosure Considerations

Most applications require installation in an industrial enclosure to reduce the effects of electrical interference and environmental exposure. Pollution Degree 2 is an environment where normally only non-conductive pollution occurs except that occasionally temporary conductivity caused by condensation shall be expected. Overvoltage Category II is the load level section of the electrical distribution system. At this level, transient voltages are controlled and do not exceed the impulse voltage capability of the product's insulation.

This equipment is intended for use in a Pollution Degree 2 industrial environment, in overvoltage Category II applications (as defined in IEC 60664-1), at altitudes up to 2000 m (6562 ft) without derating. This equipment is considered Group 1, Class A industrial equipment according to IEC/CISPR 11. Without appropriate precautions, there may be difficulties with electromagnetic compatibility in residential and other environments due to conducted and radiated disturbances.

This equipment is supplied as open-type equipment. It must be mounted within an enclosure that is suitably designed for those specific environmental conditions that will be present and appropriately designed to prevent personal injury resulting from accessibility to live parts. The enclosure must have suitable flame-retardant properties to prevent or minimize the spread of flame, complying with a flame spread rating of 5VA, V2, V1, V0 (or equivalent) if non-metallic. The interior of the enclosure must be accessible only by the use of a tool. Subsequent sections of this publication may contain additional information regarding specific enclosure type ratings that are required to comply with certain product safety certifications.

In addition to this publication, see:

- Industrial Automation Wiring and Grounding Guidelines, Rockwell Automation publication 1770-4.1, for additional installation requirements.
- NEMA Standard 250 and IEC 60529, as applicable, for explanations of the degrees of protection provided by different types of enclosure.

Preventing Excessive Heat

For most applications, normal convective cooling keeps the controller within the specified operating range. Ensure that the specified temperature range is maintained. Proper spacing of components within an enclosure is usually sufficient for heat dissipation.

In some applications, a substantial amount of heat is produced by other equipment inside or outside the enclosure. In this case, place blower fans inside the enclosure to assist in air circulation and to reduce "hot spots" near the controller.

Additional cooling provisions might be necessary when high ambient temperatures are encountered. Do not bring in unfiltered outside air. Place the controller in an enclosure to protect it from a corrosive atmosphere. Harmful contaminants or dirt could cause improper operation or damage to components. In extreme cases, you may need to use air conditioning to protect against heat buildup within the enclosure.

Notes:

Power, Ground, and Wiring

Wiring Requirements and Recommendation

WARNING: Before you install and wire any device, disconnect power to the system.

WARNING: Calculate the maximum possible current in each power and common wire. Observe all electrical codes dictating the maximum current allowable for each wire size. Current above the maximum ratings may cause wiring to overheat, which can cause damage.

- Allow for at least 50 mm (2 in.) between I/O wiring ducts or terminal strips and the relay.
- Route incoming power to the relay by a path separate from the device wiring. Where paths must cross, their intersection should be perpendicular.
- Do not run signal or communications wiring and power wiring in the same conduit. Wires with different signal characteristics should be routed by separate paths.
- Separate wiring by signal type. Bundle wiring with similar electrical characteristics together.
- Separate input wiring from output wiring.
- Label wiring to all devices in the system. Use tape, shrink-tubing, or other dependable means for labeling purposes. In addition to labeling, use colored insulation to identify wiring based on signal characteristics. For example, you may use blue for DC wiring and red for AC wiring.

Wire Size

Table 1 - Wiring Requirements

	Wire Size			
	Type	**Min**	**Max**	rated @ 90 °C (194 °F) insulation min.
Copper	Stranded	0.326 mm^2 (22 AWG)	1.31 mm^2 (16 AWG)	

Terminal Assignments

Some terminals are designed to have one specific function. Some terminals can perform multiple functions; these terminals must be configured in the application software.

Table 2 - Terminal Assignments

Terminal	Function
00	Safety Input (N.C.)
01	Safety Input (N.C.)
02	Safety Input (N.C.)
03	Safety Input (N.C.)
04	Safety Input (N.C.)
05	Safety Input (N.C.)
06	Safety Input (N.C.)
07	Safety Input (N.C.)
08	Safety Input (N.C.)
09	Safety Input (N.C.)
10	Safety Input (N.C.) or Single Wire Safety Input
11	Safety Input (N.C.) or Single Wire Safety Input
+24V DC	A1 Power Supply (+24V, -15%, + 10%)
COM 0V	A2 Power Supply (0V)
12	Test Output or OSSD High Side or Safety Input (N.C.) or Safety Input N.O. or standard diagnostic.
13	Test Output or OSSD High Side or Safety Input (N.C.) or Safety Input N.O. or standard diagnostic.
14	Test Output or OSSD High Side or Safety Input (N.C.) or Safety Input N.O. or standard diagnostic.
15	Test Output or OSSD High Side or Safety Input (N.C.) or Safety Input N.O. or standard diagnostic.
16	Test Output or OSSD High Side or Safety Input (N.C.) or Safety Input N.O. or standard diagnostic.
17	Test Output or OSSD High Side or Safety Input (N.C.) or Safety Input N.O. or standard diagnostic.
18	OSSD High Side
19	OSSD High Side
20	OSSD High Side or Single Wire Safety Output
21	OSSD High Side or Single Wire Safety Output

Grounding the Configurable Safety Relay

WARNING: All devices connected to the RS-232 communication port must be referenced to controller ground, or be floating (not referenced to a potential other than ground). Failure to follow this procedure may result in property damage or personal injury.

This product is intended to be mounted to a well grounded mounting surface such as a metal panel. Refer to the Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1, for additional information.

Connecting a Power Supply

Power for the relay is provided by an external 24V DC power supply source.

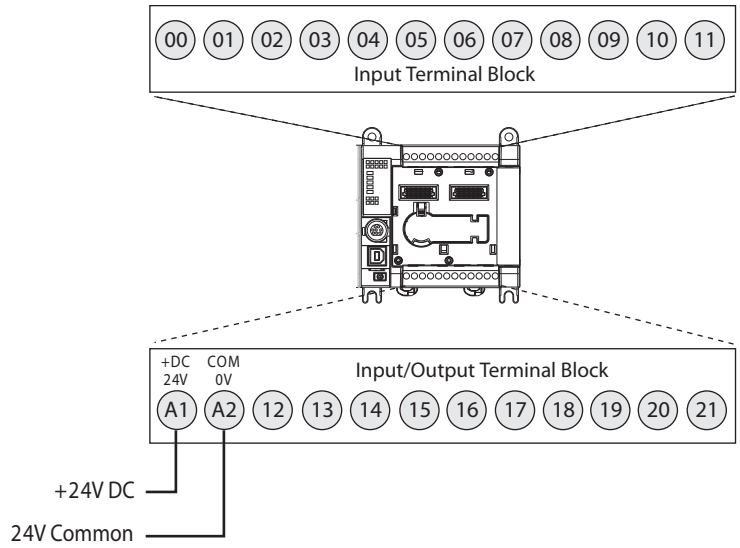
To comply with the CE Low Voltage Directive (LVD), the I/O must be powered by a DC source compliant with Safety Extra Low Voltage (SELV) or Protected Extra Low Voltage (PELV).

To comply with UL restrictions, I/O must be powered by DC sources whose secondary circuits are isolated from the primary circuit by double insulation or reinforced insulation. The DC power supply must satisfy the requirements for Class 2.

The following Rockwell Automation power supplies are SELV- and PELV-compliant, and they meet the isolation and output hold-off time requirements of the CR30 relay:

- 2080-PS120-240VAC
- 1606-XLP30E
- 1606-XLP50E
- 1606-XLP50EZ
- 1606-XLP72E
- 1606-XLP95E
- 1606-XLDNET4
- 1606-XLSDNET4

Figure 5 - Power Supply


00 01 02 03 04 05 06 07 08 09 10 11
Input Terminal Block
+DC 24V
COM 0V
Input/Output Terminal Block
A1 A2 12 13 14 15 16 17 18 19 20 21
+24V DC
24V Common

Wire Input Devices

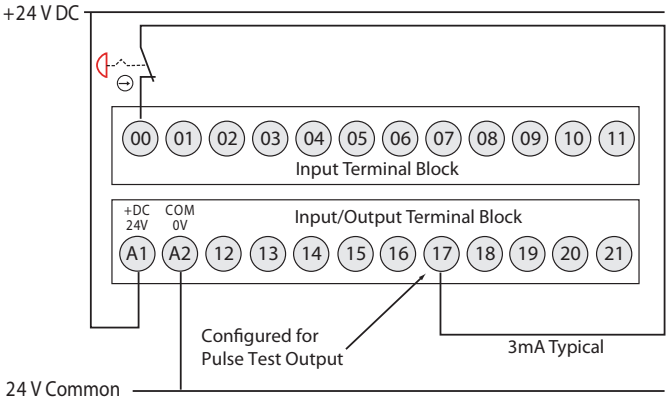
Input Devices with Mechanical Contacts

WARNING: Applying an inappropriate DC or any AC voltage may result in a loss of safety function, product damage, or serious injury. Properly apply only the specified voltage to relay inputs.

Input devices with mechanical contact outputs, such as emergency stop buttons and safety limit switches, use both a safety input terminal and a test output terminal. This enables the circuit to achieve a Category 4 rating.

When safety devices are connected via test outputs to an input circuit on the CR30 relay, we recommend the length of the wire to be 30 m (98.4 ft) or less.

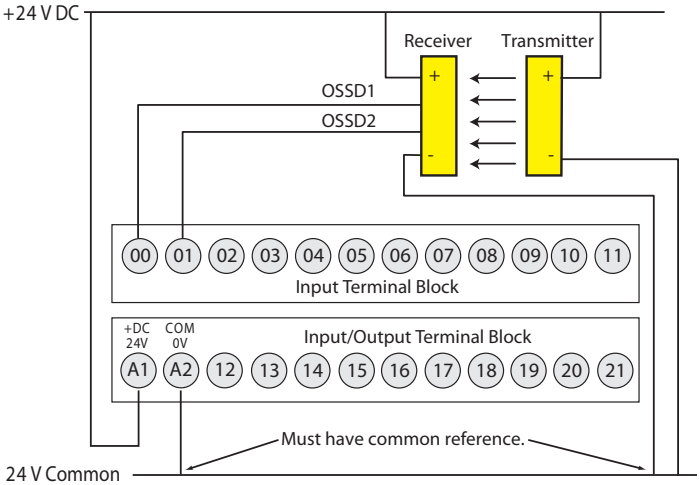
Figure 6 - Input Devices with Mechanical Contacts


+24 V DC
00 01 02 03 04 05 06 07 08 09 10 11
Input Terminal Block
+DC 24V
COM 0V
Input/Output Terminal Block
A1 A2 12 13 14 15 16 17 18 19 20 21
Configured for Pulse Test Output
3mA Typical
24 V Common

Input Devices with OSSD Outputs

Devices, such as light curtains, laser scanners and solid-state interlocks, having current-sourcing PNP semiconductor outputs (OSSD) have built-in test pulses (or other method of detecting faults). These devices are connected directly to the inputs of the CR30 relay safety and do not use a test output. These devices must have a common reference with the CR30.

Figure 7 - Input Devices with OSSD Outputs



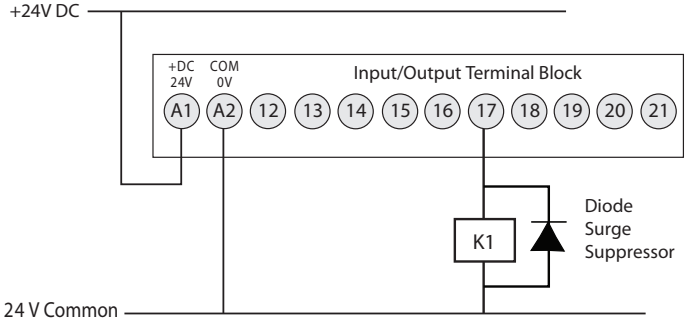
Wire Output Devices

Use Surge Suppressors

Because of the potentially high current surges that occur when switching inductive load devices, such as motor starters and solenoids, the use of some type of surge suppression to protect and extend the operating life of the relays output is required. By adding a suppression device directly across the coil of an inductive device, you prolong the life of the outputs. You also reduce the effects of voltage transients and electrical noise from radiating into adjacent systems.

The following diagram shows an output with a suppression device. We recommend that you locate the suppression device as close as possible to the load device. Since the outputs are 24V DC, we recommend 1N4001 (50V reverse voltage) to 1N4007 (1000V reverse voltage) diodes for surge suppression for the OSSD safety outputs, as shown below. The diode should be connected as close as possible to the load coil.

Figure 8 - Surge Suppressors



Example suppressors include:

- 100-FSD250 for Bulletin 100S Contactors
- 1492-LD4DF terminal block with built-in 1N4007 diode

The CR30 accommodates up to 24 safety monitoring functions. Examples of safety monitoring functions are single channel input, dual channel input, two hand control, reset, and feedback.

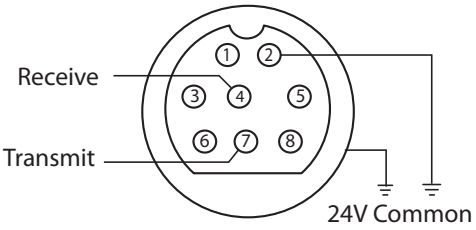
Embedded Serial Port Wiring

The embedded serial port is a non-isolated RS232 serial port which is targeted to be used for short distances (<3 m) to devices such as HMIs (e.g. PanelView). Pin 2 and the shield are both internally connected to the -24V Common (A2) terminal of the CR30.

The CR30 uses the minimal RS232 connection; only transmit (TxD), receive (RxD) and ground connections are required. The CR30 does not require nor perform any handshaking, therefore the Request To Send (RTS), Clear To Send (CTS), and Carrier Detect (DCD) are not used.

The CR30 only supports RS232. The RS485 signals, used by some products with the 8-pin mini DIN connector, are not used.

Figure 9 - Pinouts



Pin	RS-232 Example
1	RS485 (not used)
2	GND
3	RTS (not used)
4	RxD

Pin	RS-232 Example
5	DCD (not used)
6	CTS (not used)
7	TxD
8	RS485 (not used)

The table below shows a recommended list of cables for the serial connection between the CR30 and other Allen-Bradley products. They may also be suitable for third party products.

DIN connectors were originally standardized by the Deutsches Institut für Normung (DIN), the German national standards organization. Many variations of this connector exist. To ensure compatibility, please select a cable from the table below.

Table 3 - Cables

Cat. No.	Description	Length
1761-CBL-AM00	8-pin Mini DIN to 8-pin Mini DIN	0.5 m (1.5 ft)
1761-CBL-HM02	8-pin Mini DIN to 8-pin Mini DIN	2 m (6.5 ft)
1761-CBL-AP00	8-pin Mini DIN to 9-pin D Shell	0.5 m (1.5 ft)
1761-CBL-PM02	8-pin Mini DIN to 9-pin D Shell	2 m (6.5 ft)

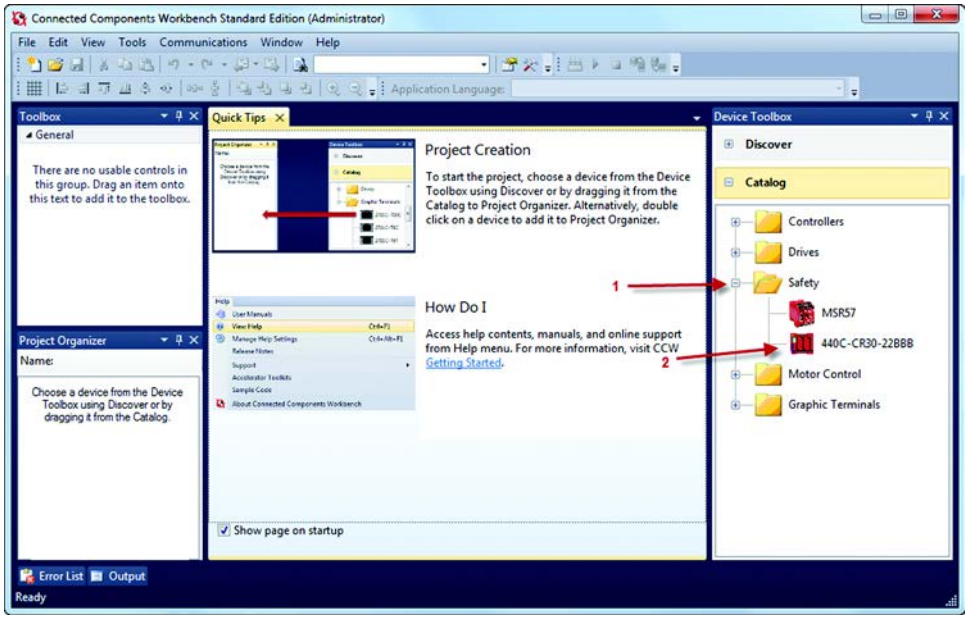
The CR30 is categorized as Data Communications Equipment (DCE). The PanelView HMI's are Data Terminal Equipment (DTE). This is important when point-to-point wiring connections are made. When DTE communicates with DCE, the connections are pin x to pin x. When DTE communicates with other DTE, a cross over is required (e.g., TxD must be connected to RxD).

Configuring the CR30

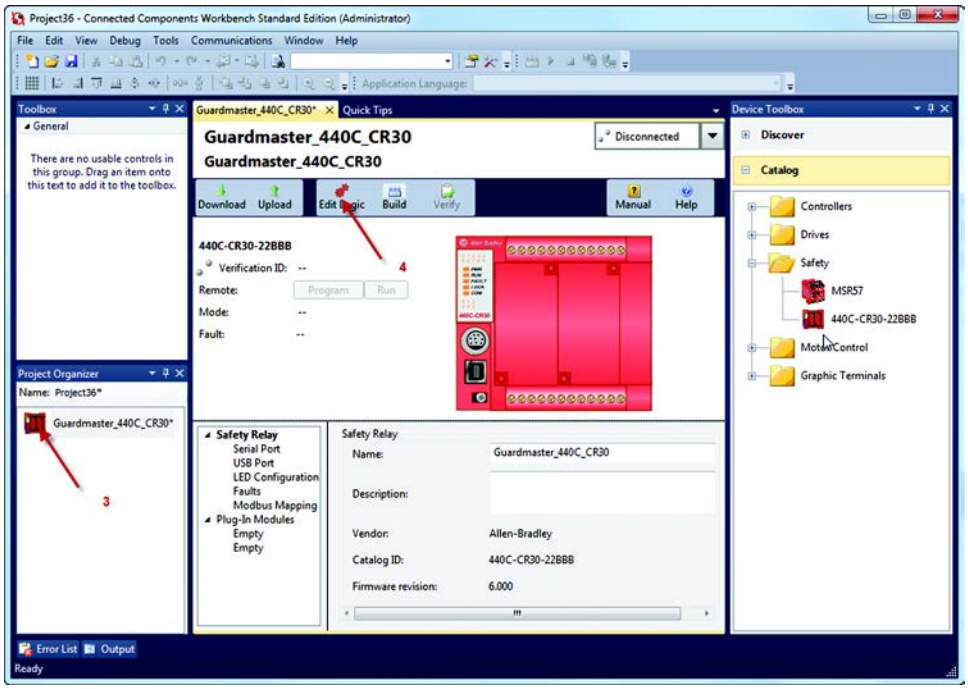
This manual assumes the user has loaded the CCW and describes basic operations. The user should use the on-line help for setting up the safety functions.

Begin Configuration

1. In the Device Toolbox, expand the Safety Catalog.
2. Double click on the 440C-CR30-22BBB to open it in the Project Organizer.


Connected Components Workbench Standard Edition (Administrator)
File Edit View Tools Communications Window Help
Application Language:
Toolbox
General
There are no usable controls in this group. Drag an item onto this text to add it to the toolbox.
Project Organizer
Name:
Choose a device from the Device Toolbox using Discover or by dragging it from the Catalog.
Quick Tips
Project Creation
To start the project, choose a device from the Device Toolbox using Discover or by dragging it from the Catalog to Project Organizer. Alternatively, double click on a device to add it to Project Organizer.
How Do I
Access help contents, manuals, and online support from Help menu. For more information, visit CCW Getting Started.
Show page on startup
Device Toolbox
Discover
Catalog
Controllers
Drives
Safety
MSR57
440C-CR30-22BBB
Motor Control
Graphic Terminals
1
2
Error List
Output
Ready

3. Double click on the icon in the Project Organizer to open the project.
4. Click on the Edit Logic button to begin the configuration process.

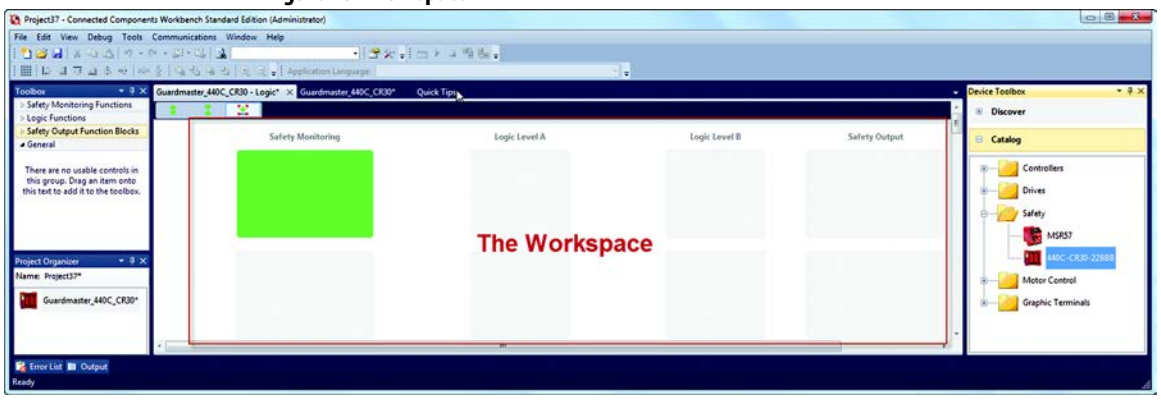


The Workspace

The workspace is set up in a grid of four columns: Safety Monitoring (the inputs), Logic Level A, Logic Level B, and Safety Output.

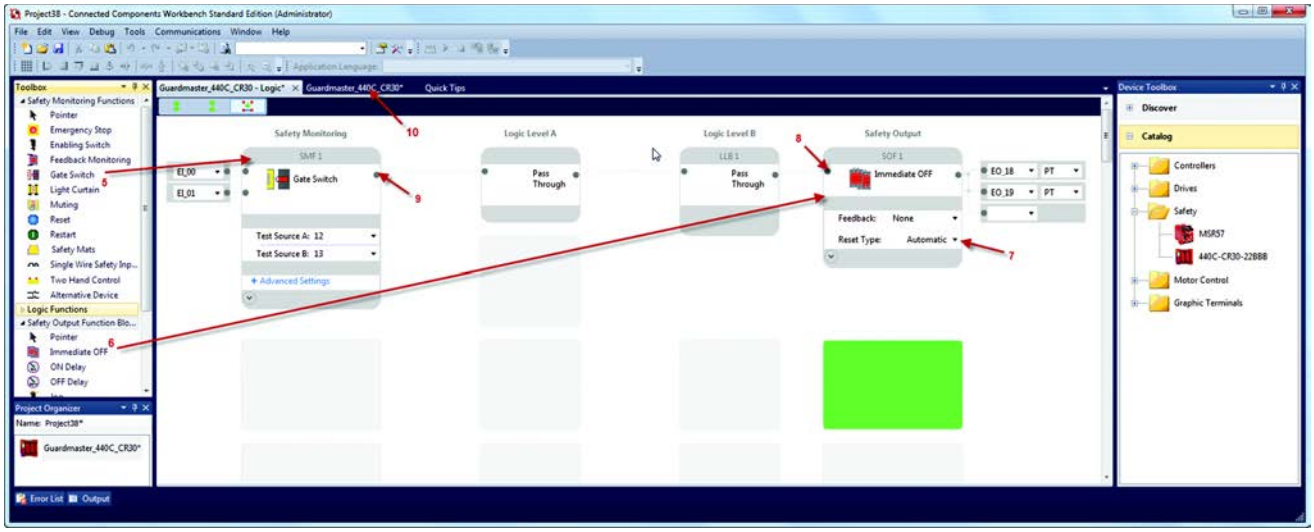
Expanding the Toolbox on the left, the user can add blocks to the Workspace and create safety functions.

Figure 10 - Workspace



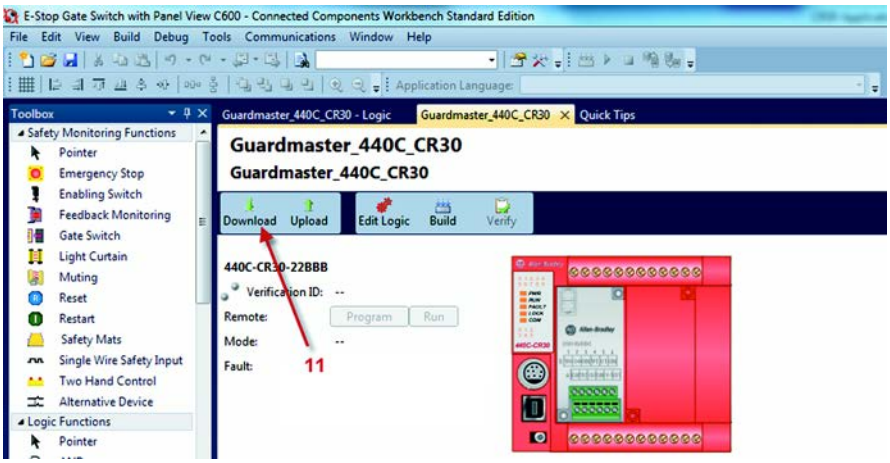
5. Click and drag the Gate Switch function block to the first block in the work space.
   The CCW automatically assigns embedded input terminals EI_00 and EI_01 to the function block. The terminal connection parameters can be changed by the user.

6. Click and drag the immediate Output to the first Safety Output block in the workspace.
   The CCW automatically assigns embedded output terminals EO_18 and EO_19 to the output block. In addition, the output terminals will be pulse tested (PT). The terminal connection parameters can be changed by the user.
7. Use the pull down menu to change the Immediate Output Reset from Manual to Automatic.
8. Click on the input connection (shown in blue when no connection is made) of the Immediate Off output block.
9. Click on the output connection of the Emergency Stop button (shown in blue when no connection is made).
   The CCW automatically creates two Pass Through blocks in Logic Level A and Logic Level B and makes the connection.
10. Click on the second tab to compile and download the configuration.

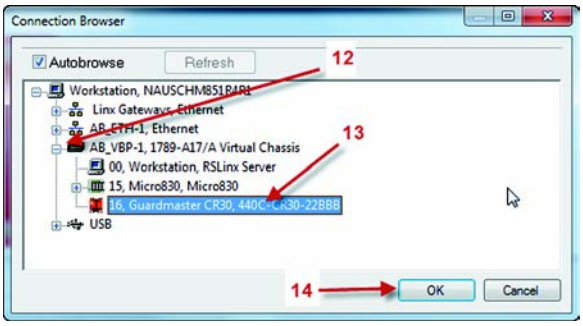


Download the Configuration

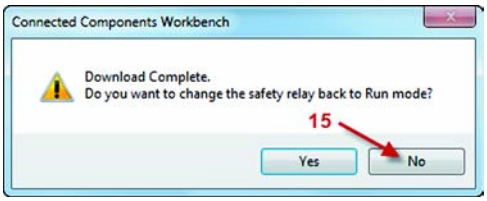
11. Click on the Download icon to build and download the configuration to the CR30.



12. Expand the navigation tree.
13. Select the CR30.
14. Click OK.



15. Click No to maintain the relay in Program mode and continue with the verification process. Click Yes to skip the verification process and change the relay back to Run Mode, which allows the CR30 to operate for a maximum duration of 24 hours..

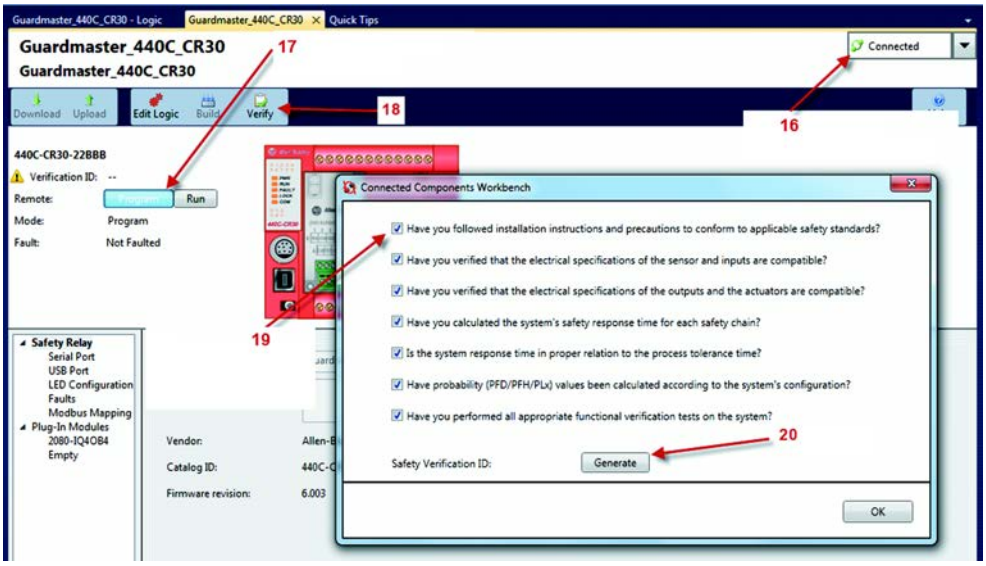


Verification

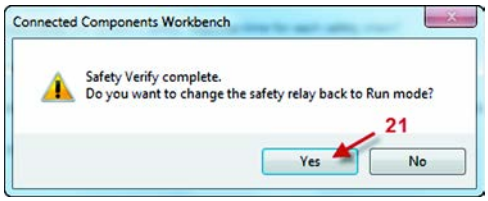
To complete the safety system requirements, the configuration of the CR30 must be verified. If the configuration is not verified, the CR30 can be placed in Run mode for only 24 hours. After 24 hours, the power to the CR30 must be cycled to restore the operation for another 24 hours. If the safety system is verified, the CR30 will be assigned a four digit number and will be allowed to operate in run mode beyond the 24 hour limit.

16. The CCW must be connected to the CR30 during verification.
17. The CR30 must be in Program mode.
18. Click the Verify button (the Safety Verification window appears).
19. Answer all the questions and check each box, if completed.
20. Click Generate.

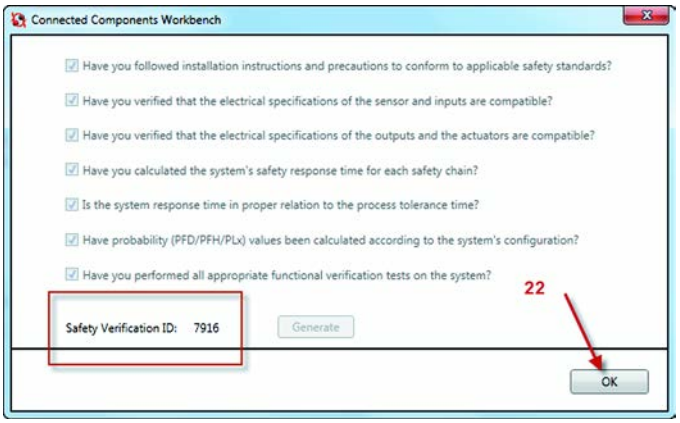
ATTENTION: The verification process should be documented in the safety system's technical file.



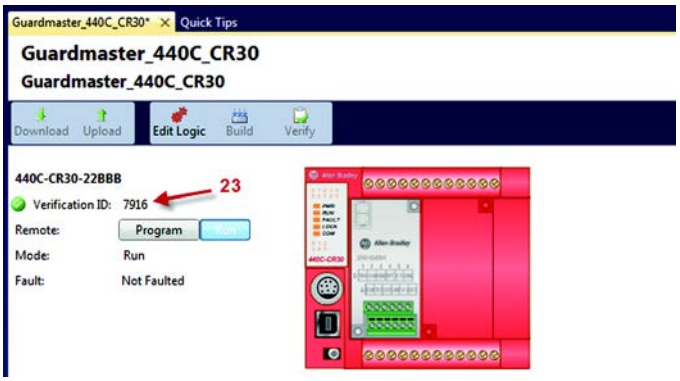
21. Click Yes to change the safety relay back to Run mode.



22. The CCW generates a Safety Verification ID. Click OK to continue.


Connected Components Workbench
Have you followed installation instructions and precautions to conform to applicable safety standards?
Have you verified that the electrical specifications of the sensor and inputs are compatible?
Have you verified that the electrical specifications of the outputs and the actuators are compatible?
Have you calculated the system's safety response time for each safety chain?
Is the system response time in proper relation to the process tolerance time?
Have probability (PFD/PFH/PLx) values been calculated according to the system's configuration?
Have you performed all appropriate functional verification tests on the system?
22
Safety Verification ID: 7916
Generate
OK

23. Confirm the Verification ID in the CCW.
The ID is stored in the CR30. During power-up, the CR30 uses this number during its self-testing to help ensure its internal processors are functioning properly. When the configuration is uploaded from the CR30, the CCW will show the Verification ID.
The ID is not stored with the CCW project file.

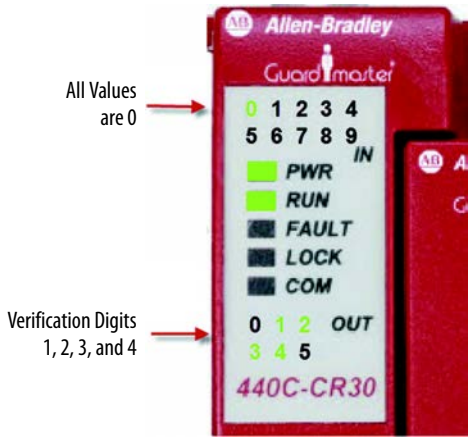


Viewing Verification ID without CCW

The LEDs can be used to view the verification ID without the use of the CCW.

If the CR30 configuration has not been verified, the ID is 0000. Press and release the Verification button. The IN 0 LED will be green. The OUT 1, 2, 3, and 4 LEDs will be green. After five seconds, the LEDS will revert to showing the status of the inputs and outputs as configured in the CCW.

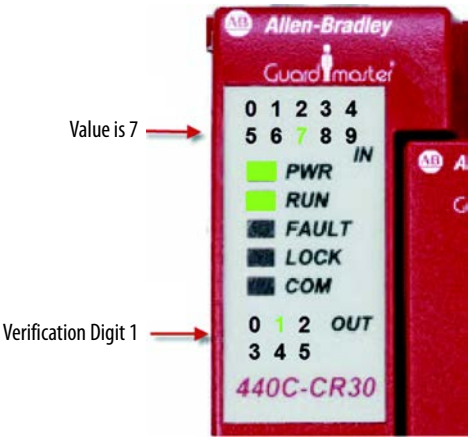
Figure 11 - Verification ID is 0000 (not verified)



If the CR30 configuration has been verified, pressing the Verification button will cycle the LEDs through each verification digit. In the following example, the Verification ID is 7916.

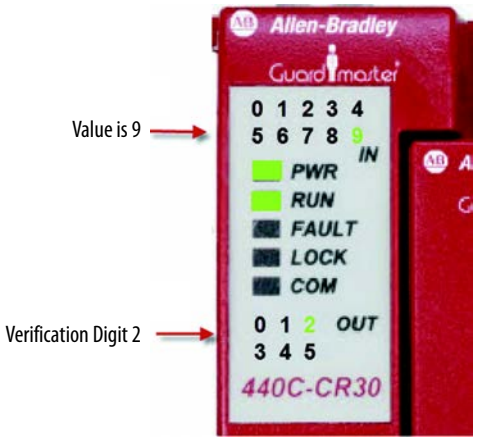
Press and release the verification button once.

Figure 12 - First Verification Digit



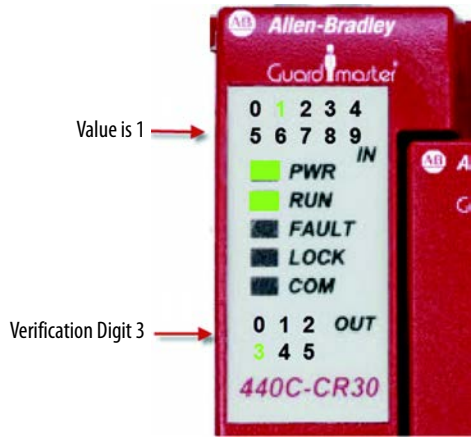
Press the Verification button within five seconds.

Figure 13 - Second Verification Digit



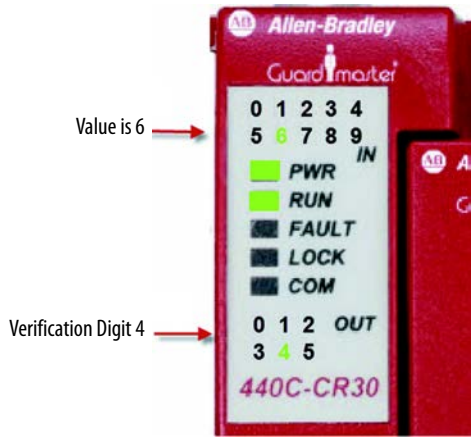
Press the Verification button within five seconds.

Figure 14 - Third Verification Digit



Press the Verification button within five seconds.

Figure 15 - Fourth Verification Digit



Let five seconds elapse and the LED will show the status of the inputs and outputs as configured in the CCW.

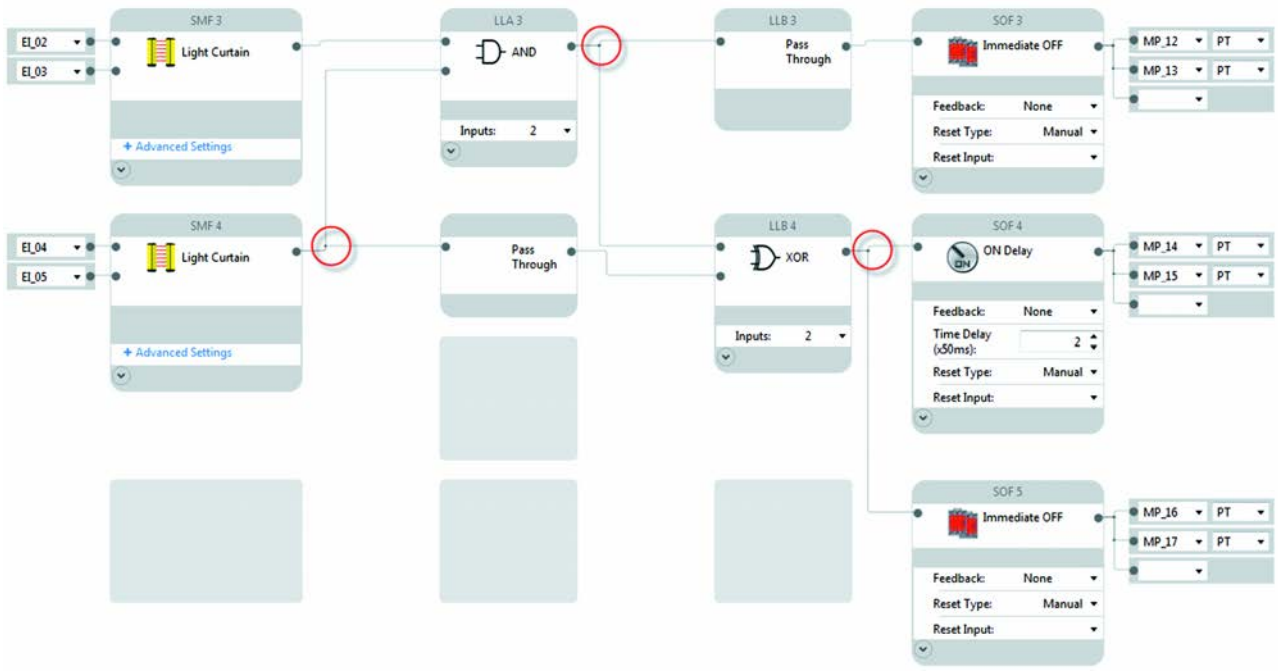
Multiple Block Connections

Multiple blocks can be connected between:

- Safety Monitoring Functions and Logic Level A
- Logic Level A and Logic Level B, and
- Logic Level B and Safety outputs

This is done by clicking on the desired input and output connection points. The CCW will automatically determine whether the connection can be made.

Figure 16 - Multiple Block Connections



Notes:

Pulse Testing

The CR30 performs three types of pulse testing functions:

- N.O. Inputs
- Pulse Testing for N.C. Inputs
- Outputs

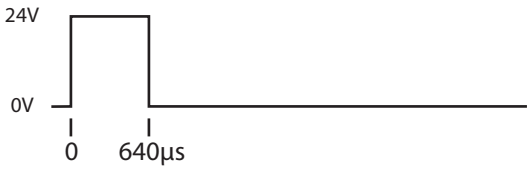
Normally Open Input Pulse Testing

When a safety input is configured for normally open (N.O.) operation, the CR30 periodically checks the status of the input. The purpose of the test pulse is to detect short circuits. This is independent of the "Input Test Pulses". Six terminals (12...17) can be configured for normally open operation.

When a terminal is configured for N.O. operation, the CR30 tests the status of each terminal by generating a test pulse as shown below.

The normally open input pulse testing cannot be configured to be on or off. If the terminal is configured to be N.O., the pulse testing will be performed by the CR30.

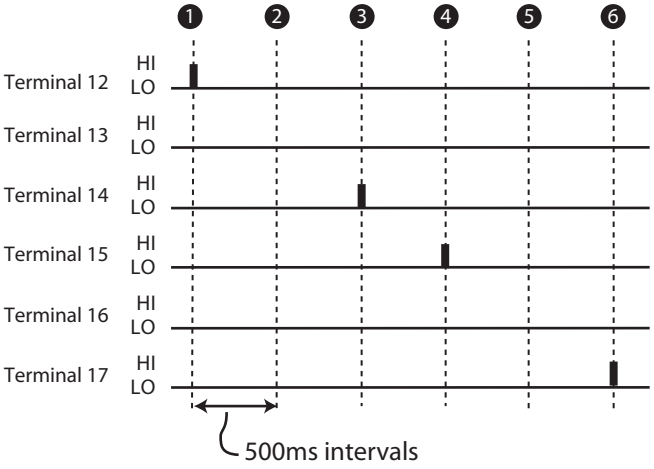
Figure 17 - N.O. Terminal Test Pulse



When multiple terminals are configured for normally open operation, the CR30 tests each one at 500 ms intervals. This test sequence is repeated every 6.4 seconds.

In the example below, terminals 12, 14, 15, and 17 are configured for N.O. operation, and are tested. Terminals 13 and 16 are configured for normally closed (N.C.) operation, therefore the test pulse does not occur on these two terminals.

Figure 18 - Test Sequence



Pulse Testing for Inputs for N.C. Contacts

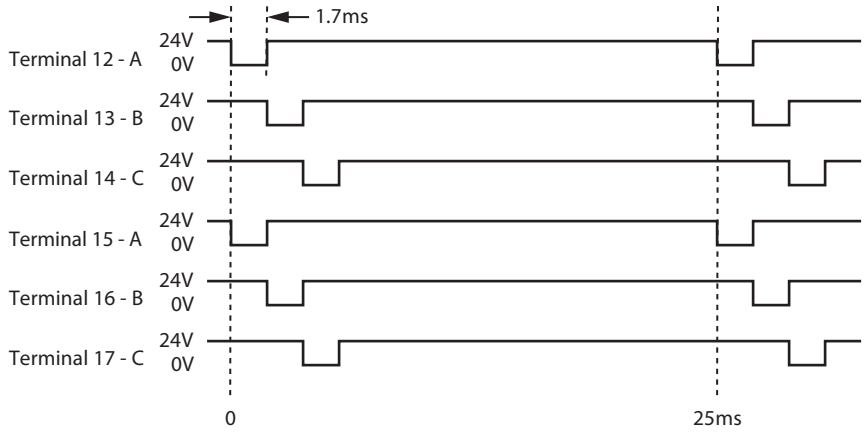
Terminals 12...17 can be configured to generate test pulse outputs. These signals are used to test for short circuit conditions on normally closed input contacts that are mechanically or electromechanically driven.

IMPORTANT Safety systems requiring a Category 4 structure per ISO13849-1 and SIL 3 rating per IEC61508 must use pulse testing for the dual channel N.C. contacts. Pulse testing for Category 3, 2, and 1 structures and SIL 2 and 1 ratings is recommended.

The CR30 generates three distinct pulses, called A, B, and C. Each pulse is 1.7 ms wide. Pulse Test B immediately follows Pulse Test A. Pulse Test C immediately follows Pulse Test B. The pulse tests are repeated every 25 ms.

The timing diagram below shows an example of the pulse testing when the respective terminals are configured for A, B, and C.

Figure 19 - Timing Diagram



The purpose of the test pulses is to detect short circuits from the input signal to 24V DC, 24V common, and shorts from one input signal to another input signal. If one input signal is assign to Test Pulse A and another signal is assigned to Test Pulse B (or C), then a short circuit from one input to the other will be detected by the CR30, and the CR30 will de-energize the outputs of those safety functions using the two inputs. In this example, the user cannot select terminal 12 as one test pulse source and terminal 15 as the second test pulse source, as both of these produce the "A" pulse.

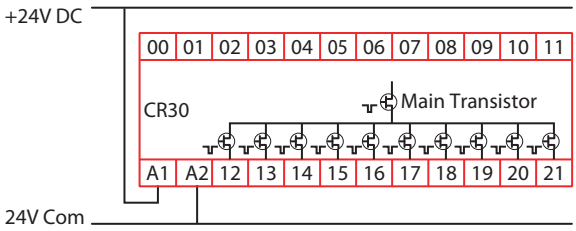
The CCW automatically prevents the user from selecting two of the same pulses when dual channel inputs and two test sources are selected.

Output Pulse Testing

Internally, the CR30 provides dual channel capability to turn off its safety outputs. Conceptually, think of this as a main output transistor feeding individual output transistors. The CR30 repeats a test process where it tests the main transistor twice and then sequentially tests each individual output twice. After successful completion of the tests, the CR30 repeats the test sequence.

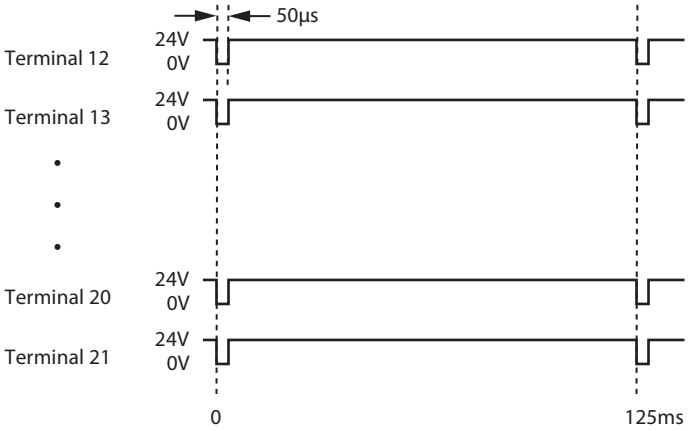
IMPORTANT Safety systems requiring a Category 4 structure per ISO13849-1 and SIL 3 rating per IEC61508 must use pulse testing for the dual channel outputs. Pulse testing for Category 3, 2, and 1 structures and SIL 2 and 1 ratings is recommended.

Figure 20 - Output Pulse Testing



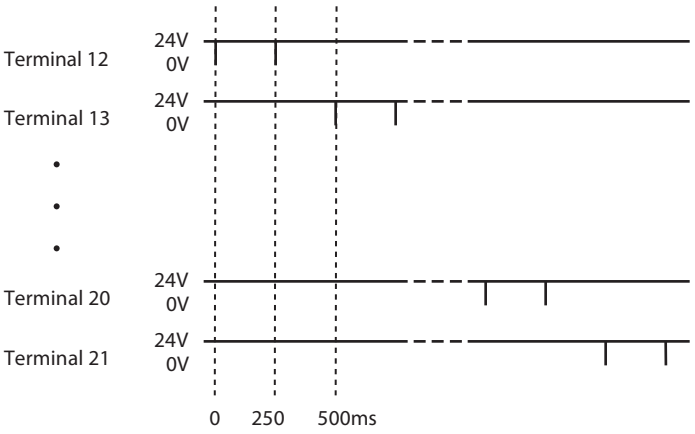
When the main transistor is tested, a 50 µs test pulse appears simultaneously on all outputs. The main transistor is tested again 125 ms later.

Figure 21 - Main Transistor Test



Then a sequence occurs in which each output is individually tested twice. The test pulse is 50 μs wide. The test pulses occur every 250 ms and switch to the next output configured with testing.

Figure 22 - Test Pulse Sequence



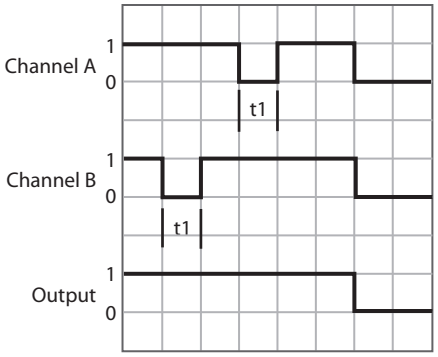
Input Filter

Input filtering gives the CR30 the ability to filter out noise and, in some cases, inadvertent operation.

Sometimes, an operator may press a push button and may immediately realize that they pressed the wrong button and immediately release the button. In muting applications, an object, moving down a conveyor, might stop just at the point where the muting sensor is deactivated and then back off just enough that the muting sensor is reactivated.

When an input filter time (t1) is specified, an input channel is allowed to go to the LO state while the other channel is in the HI state for that length of time without the output of the instruction going to the LO state. However, the output will go to the LO state when both input channels are in the LO state at the same time.

Figure 23 - Input Filtering



Input filtering can set in 25 ms increments, from 0...1000ms. The default value is 0 ms.

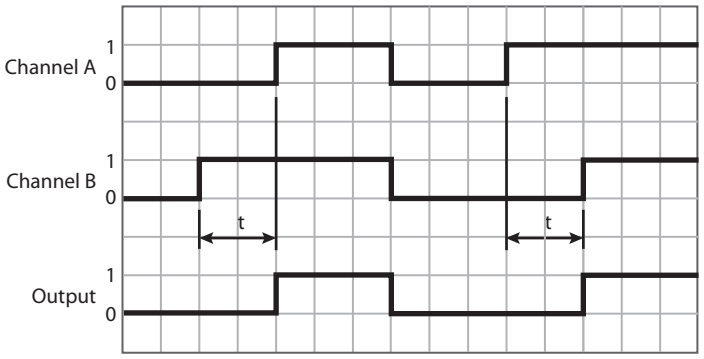
The input filtering is set in the Advanced Settings of each safety monitoring block. The example below shows the Enabling Switch function with the input filter is set to 4 (4 x 25 = 100 ms).

Discrepancy Time

Safety Monitoring functions utilizing dual inputs have a feature that allows the CR30 to test for the timing of the operation of both channels. In most cases, the outputs of dual channel safeguarding devices change state within a few milliseconds of each other. In some cases, the second channel may change state much later than the first.

In these later cases, the user may want to allow (i.e. make sure that) both channels return to their "safety" state within a specified time relative to each other. For example, the "safety" state of dual N.C. input is when both inputs are in the closed state. Channel A can close before Channel B or Channel B can close before Channel A. The CR30 allows the user to specify a discrepancy time in 50 ms increments, from 0...3 seconds.

Figure 24 - Discrepancy Time

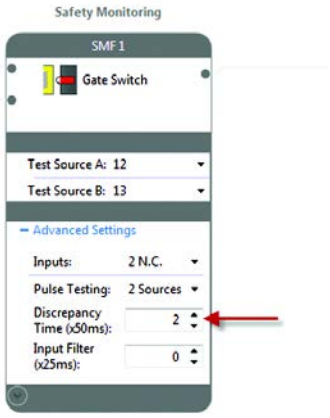


t <= Discrepancy Time

The discrepancy is set in the Advanced Settings of each safety monitoring block. The following example shows the Gate Switch function with the discrepancy time set to 2 (2 x 50 = 100 ms).

When the discrepancy setting is set to zero, the CR30 does not test for discrepancy. The duration between the operation of channel one and channel two is infinite. The default value 100 ms.

Figure 25 - Setting Discrepancy Time



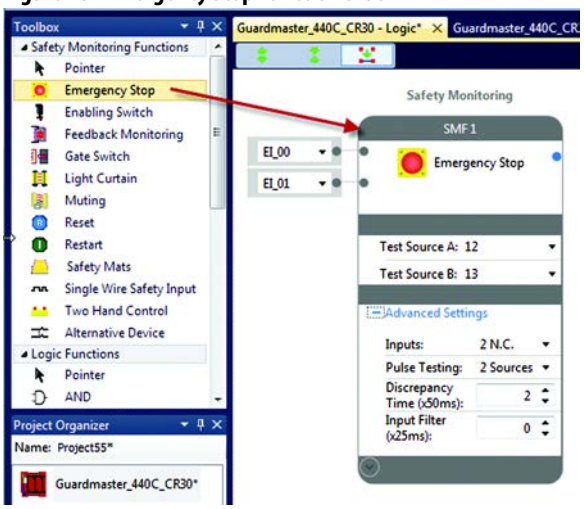
Safety Inputs

Many types of safeguarding and safety devices and safety related signals can be connected as inputs to the CR30. The CCW facilitates the selection and connection of the device. Each block is assigned the next available settings for input terminals, test sources number of inputs, pulse testing, discrepancy time, and input filter.

Emergency Stop

The Emergency Stop function block sets the parameters for typical emergency stop push-buttons. In the CCW, click and drag (or double click) the block to an available Safety Monitoring Function spot. When mechanical operated contacts are used, these contacts must be direct-acting contacts.

Figure 26 - Emergency Stop Function Block



The available input selections for the Emergency Stop inputs are:

- EI_00...EI_11 (Embedded Input Terminals 00...11)
- MP_12...MP_17 (Multi-Purpose Terminals 12...17)

The user can modify the number and types of inputs:

- 2 N.C.
- 2 OSSD
- 1 N.C.

Pulse testing can be disabled or set to 2 Sources. When 2 Sources is selected, the next available test sources are automatically selected. The user can modify the sources afterward.

The user can use the default Discrepancy Time and Input Filter or choose to modify these settings.

Figure 27 - Example Schematic of a Dual Channel E-stop Without Test Pulses

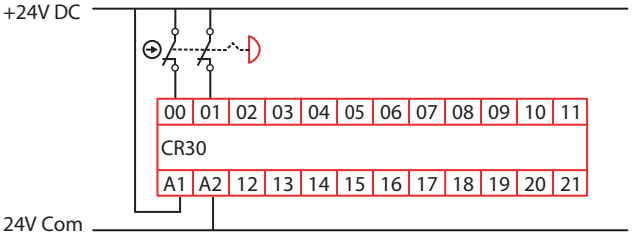
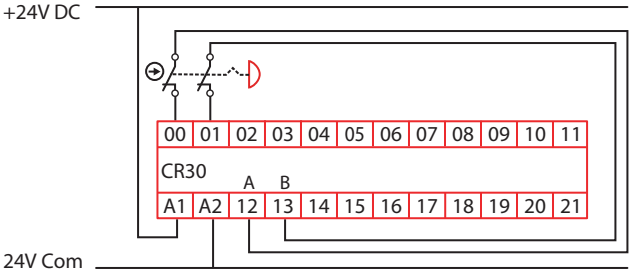


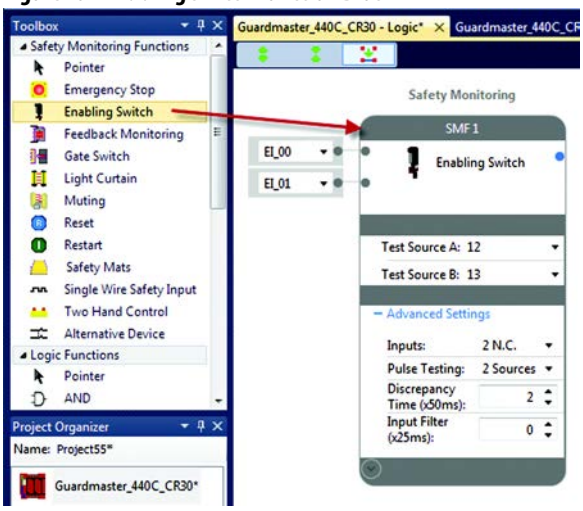
Figure 28 - Example Schematic of a Dual Channel E-stop Using Test Pulses A and B



Enabling Switch

The Enabling Switch function block sets the parameters for typical enabling (or hold-to-run) devices. In the CCW, click and drag (or double click) the block to an available Safety Monitoring Function spot. When mechanical operated contacts are used, these contacts must be direct-acting contacts.

Figure 29 - Enabling Switch Function Block



The available input selections for the Enabling Switch inputs are:

- EI_00...EI_11 (Embedded Input Terminals 00...11)
- MP_12...MP_17 (Multi-Purpose Terminals 12...17)

The user can modify the number and types of inputs:

- 2 N.C.
- 2 OSSD
- 1 N.C.

Pulse testing can be disabled or set to 2 Sources. When 2 Sources is selected, the next available test sources are automatically selected. The user can modify the sources afterward.

The user can use the default Discrepancy Time and Input Filter or choose to modify these settings.

Figure 30 - Example Schematic of a Dual Channel Enabling Switch Without Test Pulses

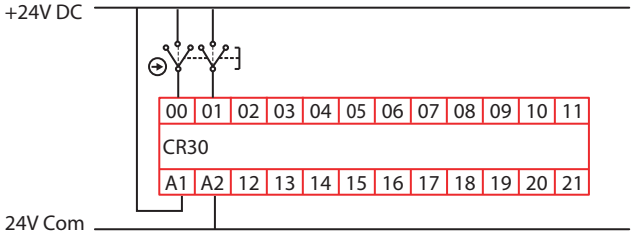
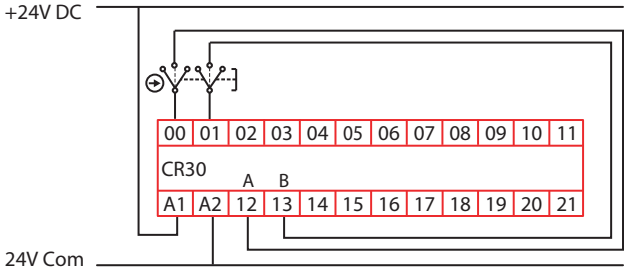


Figure 31 - Example Schematic of a Dual Channel Enabling Switch Using Test Pulses A and B



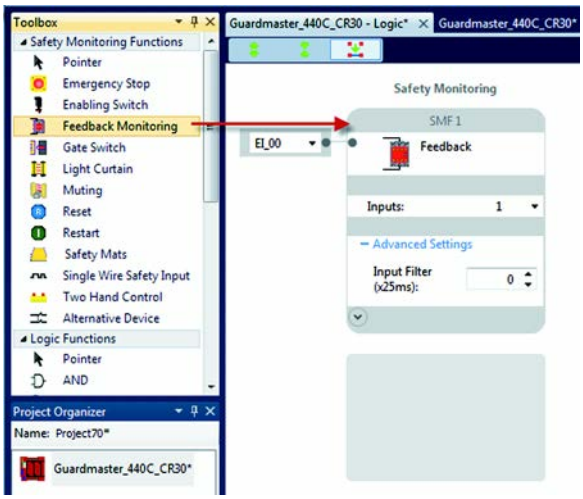
Feedback Monitoring

The Feedback function block is used in safety systems to monitor the status of output devices (like safety contactors). When the output device is off, a HI signal is fed back to the input of the CR30 to indicate that the device is indeed off. When the output device is energized, the feedback signal goes LO. If the output device were to remain energized, the feedback signal will remain LO and the CR30 will not energize the output. The feedback contacts should be positive-guided, mechanically linked, or mirrored contacts.

The CR30 accepts 1 2, 3 or 4 inputs into each feedback block. All inputs must be HI for the output of the block to go HI.

In the CCW, click and drag (or double click) the block to an available Safety Monitoring Function spot.

Figure 32 - Feedback Monitoring Function Block



The available input selections for the Feedback Monitoring are:

- EI_00...EI_11 (Embedded Input Terminals 00...11)
- MP_12...MP_17 (Multi-Purpose Terminals 12...17)
- P1_00...P1_03 (Plug-In 1 Terminals 00...03)
- P2_00...P2_03 (Plug-In 2 Terminals 00...03)
- SP_00...SP_15 (Modbus Inputs 00...05)

The user can modify the number of inputs within the range of 1...4.

The user can use the default Input Filter or choose to modify this setting.

Figure 33 - Example Feedback Schematic with Two Feedback Contacts Connected in Series to One Input Terminal

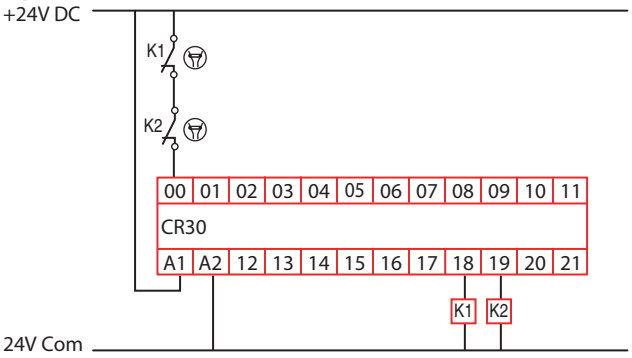
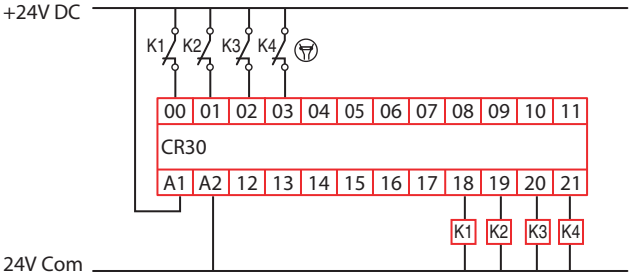


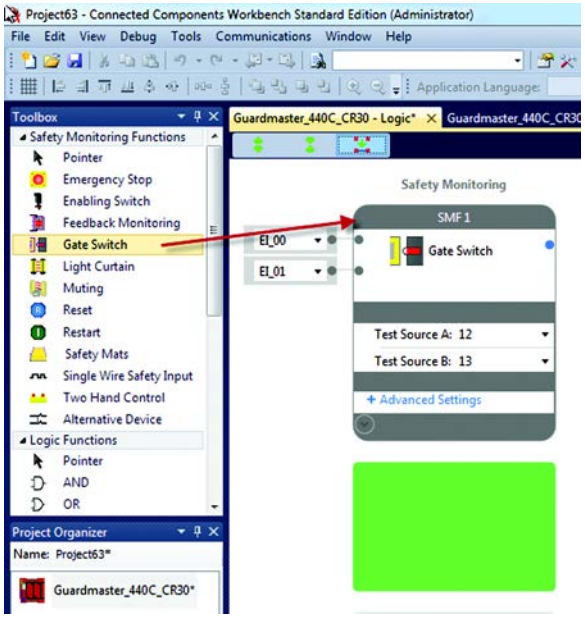
Figure 34 - Example Feedback Schematic with Four Feedback Contacts Connected Individually to Four Input Terminals



Gate Switch

The Gate Switch function block sets the parameters for typical safety gate interlock switches. In the CCW, click and drag (or double click) the block to an available Safety Monitoring Function spot.

Figure 35 - Gate Switch Function Block



The available input selections for the Gate Switch inputs are:

- EI_00...EI_11 (Embedded Input Terminals 00...11)
- MP_12...MP_17 (Multi-Purpose Terminals 12...17)

The user can modify the number and types of inputs:

- 2 N.C.
- 2 OSSD
- 1 N.C.

Pulse testing can be disabled or set to 2 Sources. When 2 Sources is selected, the next available test sources are automatically selected. The user can modify the sources afterward.

The user can use the default Discrepancy Time and Input Filter or choose to modify these settings.

Figure 36 - Example Schematic of a Dual Channel Safety Gate Switch Without Test Pulses

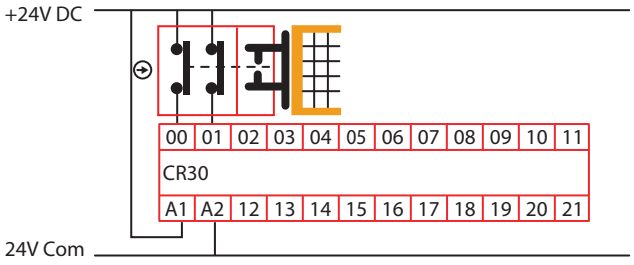


Figure 37 - Example Schematic of a Dual Channel Safety Gate Switch Using Test Pulses A and B

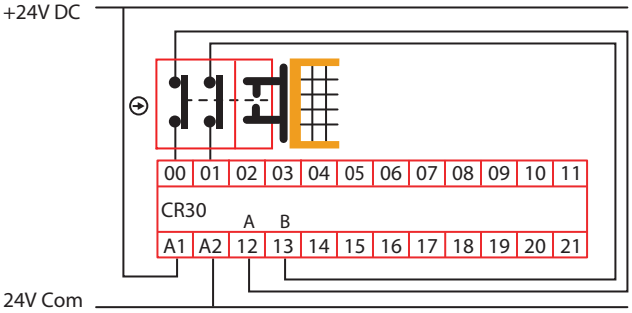
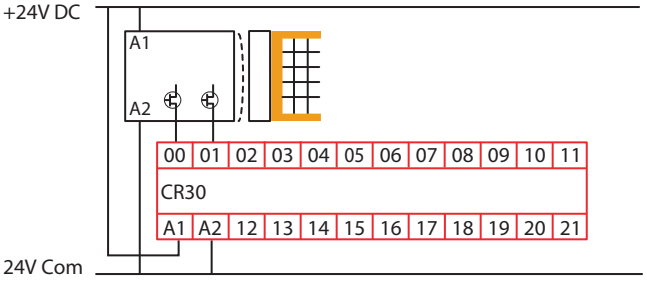


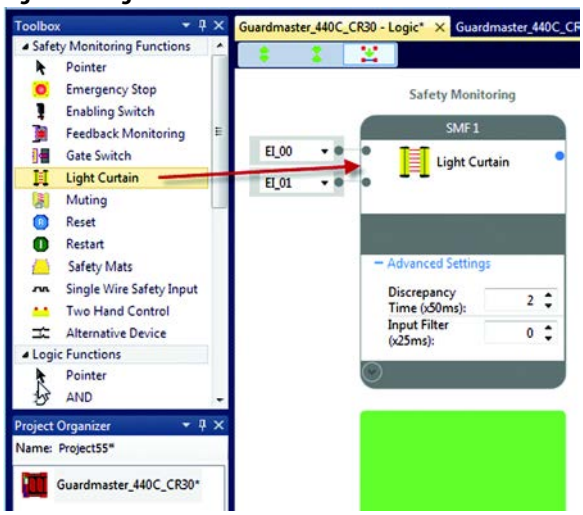
Figure 38 - Example Schematic of a Dual Channel Safety Gate Switch Using OSSD Outputs



Light Curtain

The Light Curtain function block sets the parameters for light curtains that have dual OSSD outputs. In the CCW, click and drag (or double click) the block to an available Safety Monitoring Function spot. This block can be used for other devices, like laser scanners, with OSSD outputs.

Figure 39 - Light Curtain Function Block

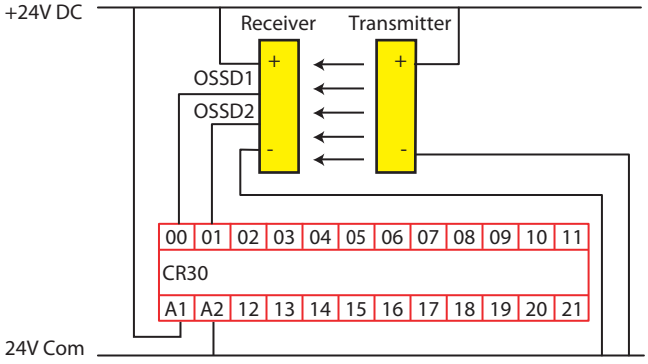


The available input selections for the Light Curtain inputs are:

- EI_00...EI_11 (Embedded Input Terminals 00...11)
- MP_12...MP_17 (Multi-Purpose Terminals 12...17)

The user can use the default Discrepancy Time and Input Filter or choose to modify these settings.

Figure 40 - Example Schematic of a Light Curtain

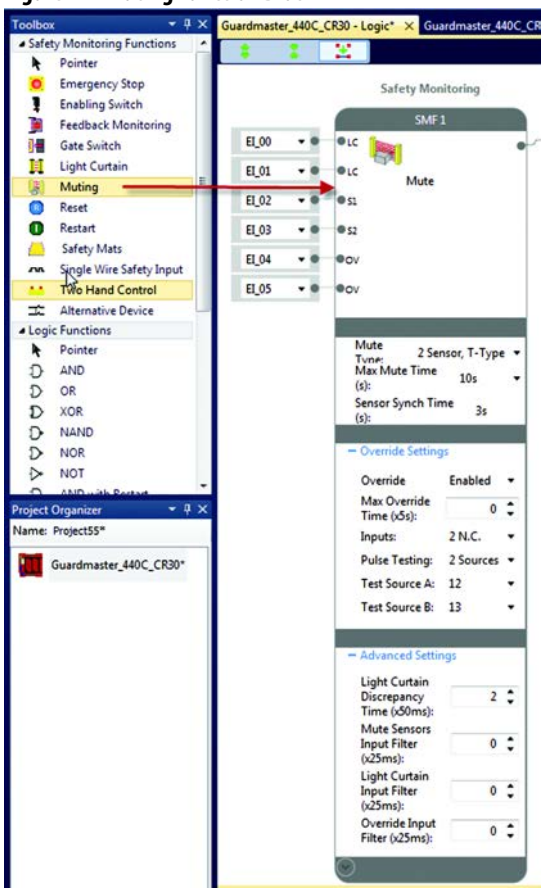


Muting

Muting is the temporary automatic suspension of the protective function of a safeguarding device like a light curtain. The muting function allows the transport of material through a light curtain without stopping a conveyor. To distinguish between material and persons, a certain sequence of events and timings are used.

Muting sensors are mounted in a certain pattern, and the material must pass by the sensors and light curtain within specified time limits. If the muting sensor sequence is incorrect or the timing parameters are violated, the conveyor is turned off. An override signal moves the material through the light curtain after a violation.

Figure 41 - Muting Function Block



The light curtain (LC) signals can use the following terminals:

- EI_00...EI_11 (Embedded Input Terminals 00...11)
- MP_12...MP_17 (Multi-Purpose Terminals 12...17)

The muting (S1...S4) and override (OV) signals can use the following terminals:

- EI_00...EI_11 (Embedded Input Terminals 00...11)
- MP_12...MP_17 (Multi-Purpose Terminals 12...17)
- P1_00...P1_03 (Plug-In 1 Terminals 00...03)
- P2_00...P2_03 (Plug-In 2 Terminals 00...03)

The user can use the default Discrepancy Time and Input Filters or choose to modify these settings.

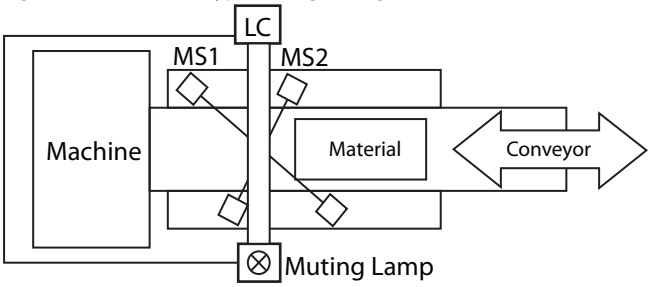
The CR30 safety relay has three distinct types of muting, where the sequence and timing of signals monitored by the CR30 allows objects to pass through the light curtain without shutting down the machine process. The three types are:

- 2-Sensor T-Type
- 2-Sensor L-Type
- 4-Sensor

2-Sensor T-Type Muting

The sensors and light curtain form the shape of an upside down "T", when viewed from the side. The muting sensors (MS) are mounted to form an "X" sensing pattern where the sensing beams cross near the center of the light curtain (LC).

Figure 42 - 2-Sensor T-Type Muting Arrangement

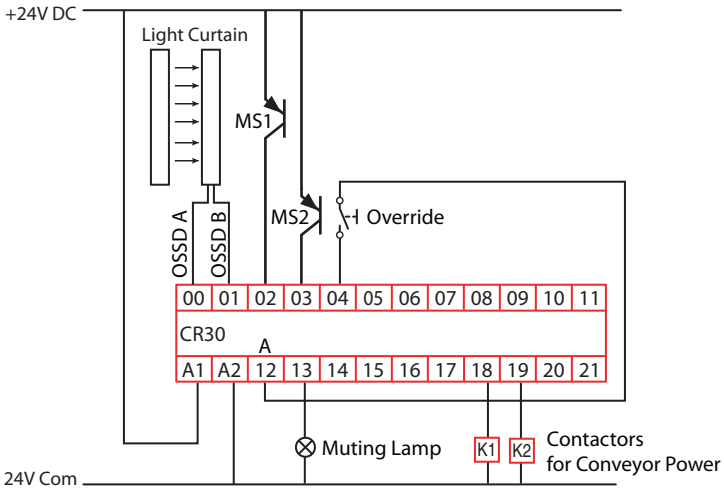


The material must first break MS1, then MS2 and then the light curtain. As the material clears the light curtain, it must clear MS2 and then MS1. The muting lamp turns on, and the light curtain is muted after MS2 is blocked. The conveyor can move in the forward or reverse direction.

In the example below, the OSSD outputs of the light curtain are connected to terminals 00 and 01. The two muting sensors are connected to terminals 02 and 03. The momentary, normally open override switch is connected between terminals 12 to 04 to take advantage of pulse testing. Contactor K1 and K2, which provide power to the conveyor (and to other hazards), are connected to terminals 18 and 19.

The muting lamp is connected to terminal 13; this terminal should be configured with no pulse testing. Filament lamps will not be affected by pulse testing, but LED lamps may appear to flicker if pulse testing is enabled.

Figure 43 - Example Schematic for 2-Sensor T-Type Muting



For simplicity, the power and ground connections of the light curtain and muting sensors are not shown. The light curtain and muting sensors must have the same reference (24V Com) as the CR30 for proper operation.

For proper operation, the muting sensors are on (normally closed) when not muting, and the light curtain OSSD outputs are also on (the light curtain is clear).

Figure 44 - Muting Time for 2-Sensor T-Type Muting

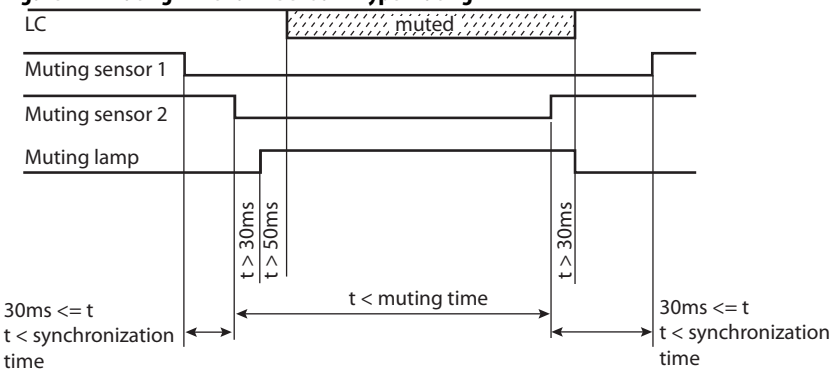


Table 4 shows the muting and synchronization times that are selectable in the CCW. These times are linked. For example, if the user selects a 10 s muting time, then the synchronization time between MS1 and MS2 is 3 s. To use a synchronization time of 6 s, the user must select a 60 s muting time.

Table 4 - Muting and Synchronization Timing Selections

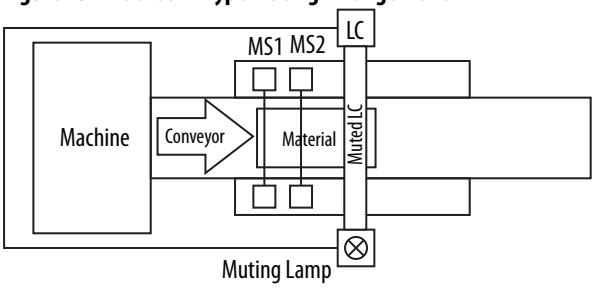
Muting Time	Synchronization Time
10 s	3 s
20 s	3 s
30 s	3 s
60 s (1 min)	6 s
300 s (5 min)	30 s

Muting Time	Synchronization Time
900 s (15 min)	90 s
1800 s (30 min)	180 s (3 min)
3600 s (1 hr)	180 s (3 min)
28,800 s (8 hr)	180 s (3 min)
Infinite	Infinite

2-Sensor L-Type Muting

The sensors and light curtain form the shape of the letter "L", when viewed from the side. The muting sensors (MS) are mounted on one side of the light curtain (LC).

Figure 45 - 2-Sensor L-Type Muting Arrangement



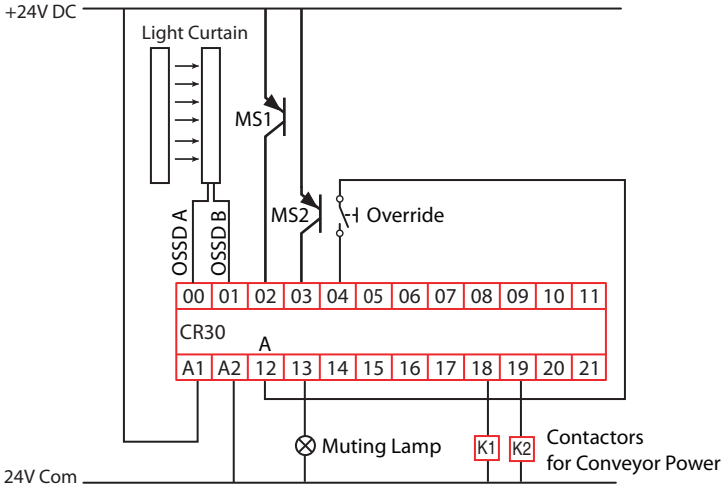
The material must first break MS1, then MS2 and then the light curtain. As the material progresses, the material must clear MS1 and then MS2. The muting lamp turns on and the light curtain is muted after MS2 is blocked. The conveyor can only move one direction.

IMPORTANT The 2-L muting arrangement must only be used for material exiting the hazard area. It must not be used for material entering the hazard area.

In the example below, the OSSD outputs of the light curtain are connected to terminals 00 and 01. The two muting sensors are connected to terminals 02 and 03. The momentary, normally open override switch is connected between terminals 12 to 04 to take advantage of pulse testing. Contactor K1 and K2, which provide power to the conveyor (and other hazards if necessary), are connected to terminals 18 and 19.

The muting lamp is connected to terminal 13; this terminal should be configured with no pulse testing. Filament lamps will not be affected by pulse testing, but LED lamps may appear to flicker if pulse testing is enabled.

Figure 46 - Example Schematic for 2-Sensor L-Type Muting



For simplicity, the power and ground connections of the light curtain and muting sensors are not shown. The light curtain and muting sensors must have the same reference (24V Com) as the CR30 for proper operation.

For proper operation, the muting sensors are on (normally closed) when not muting, and the light curtain OSSD outputs are also on (the light curtain is clear).

Figure 47 - Muting Time for 2-Sensor L-Type Muting

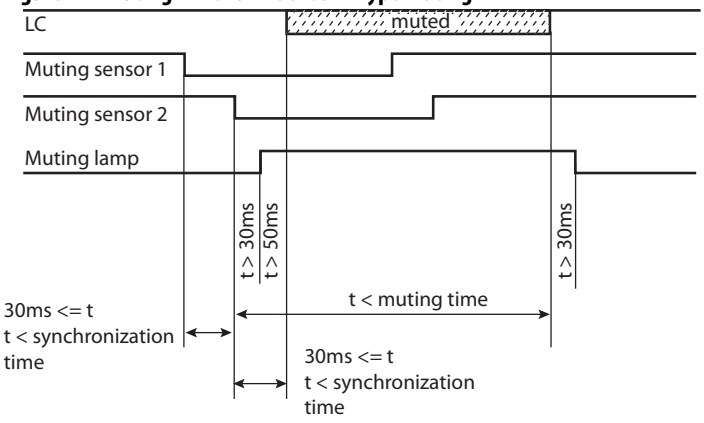


Table 5 shows the muting and synchronization times that are selectable in the CCW. These times are selected independently. For example, the user can select 2 minute muting time, a 500 ms synchronization time between MS1 and MS2 and a 1000 ms synchronization time between MS2 and the light curtain.

Table 5 - Muting and Synchronization Times for '2L' Muting

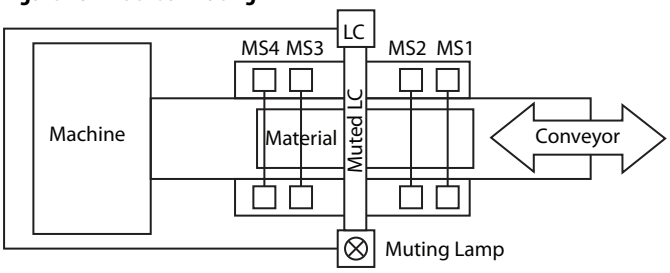
Muting Time Units	Available Values
Seconds	1…59
Minutes	1…59
Hours	1…23
Days	1…10

Synchronization Time	Available Values
MS1 to MS2	50…10,000 ms in 50 ms increments
MS2 to LC	

4-Sensor Muting

The sensors and light curtain form the shape of an upside down "T", when viewed from the side. Two muting sensors (MS) are mounted on either side of the light curtain (LC).

Figure 48 - 4-Sensor Muting

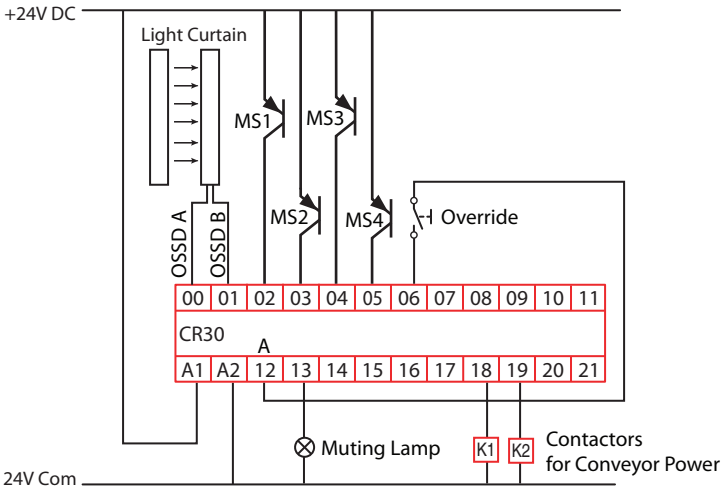


The material can travel in either direction; breaking MS1 first and MS4 last or breaking MS4 first and MS1 last. The muting lamp turns on and the light curtain is muted after the second sensor is blocked. The object must be large enough to break all four sensors.

In the example below, the OSSD outputs of the light curtain are connected to terminals 00 and 01. The four muting sensors are connected to terminals 02 to 05. The momentary, normally open override switch is connected between terminals 12 to 06 to take advantage of pulse testing. Contactor K1 and K2, which provide power to the conveyor (and other hazards if necessary), are connected to terminals 18 and 19.

The muting lamp is connected to terminal 13; this terminal should be configured with no pulse testing. Filament lamps will not be affected by pulse testing, but LED lamps may appear to flicker if pulse testing is enabled.

Figure 49 - Example Schematic for 4-Sensor Muting



For simplicity, the power and ground connections of the light curtain and muting sensors are not shown. The light curtain and muting sensors must have the same reference (24V Com) as the CR30 for proper operation.

For proper operation, the muting sensors are on (normally closed) when not muting, and the light curtain OSSD outputs are also on (the light curtain is clear).

Figure 50 - Muting Time for 4-Sensor Muting

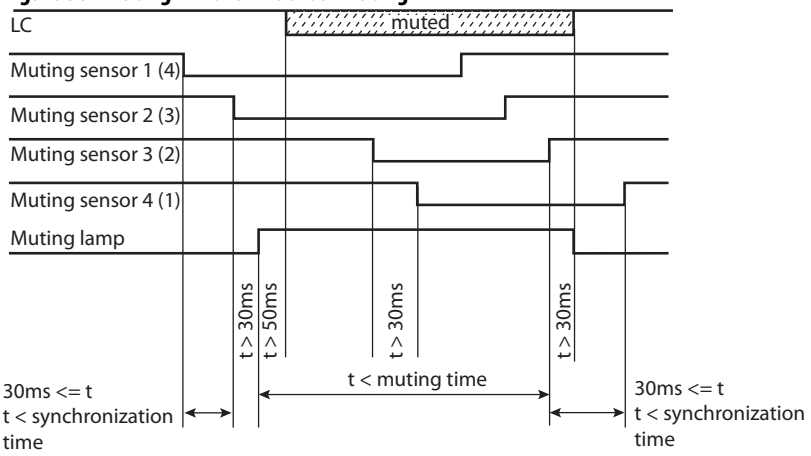


Table 6 shows the muting and synchronization times that are selectable in the CCW. These times are linked. For example, if the user selects a 10 s muting time, then the synchronization time between MS1 and MS2 is 3 s. To use a synchronization time of 6 s, the user must select a 60 s muting time.

Table 6 - Muting and Synchronization Times for 4 Sensor Muting

Muting Time	Synchronization Time
10 s	3 s
20 s	3 s
30 s	3 s
60 s (1 min)	6 s
300 s (5 min)	30 s
900 s (15 min)	90 s
1800 s (30 min)	180 s (3 min)
3600 s (1 hr)	180 s (3 min)
28800 s (8 hr)	180 s (3 min)
Infinite	Infinite

Muting Override

The muting function has an optional override input. Use the override to turn on the conveyor to clear objects through the sensors in the case of a muting sequence or timing fault.

To use the override, simply enable the feature in the safety monitoring function block. The muting override can be either a single or dual input and can also use input pulse testing if desired.

When the muting override input turns on, the safety outputs controlled by the muting function turn on until the override time expires or the override input turns off. The muting override can be set between 5...1275 seconds, in 5 second increments.

Muting Lamp

The muting lamp shows four states.

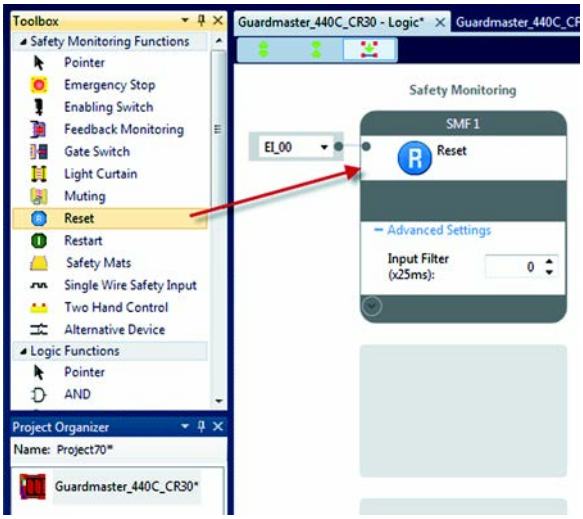
- OFF – light curtain is not muted.
- ON – light curtain is muted.
- 1Hz blink rate – muting sequence fault.
- 3Hz blink rate – muting is overridden (the Override input is on).

The muting lamp is not monitored. If the lamp burns out, the muting function will continue to work properly.

Reset

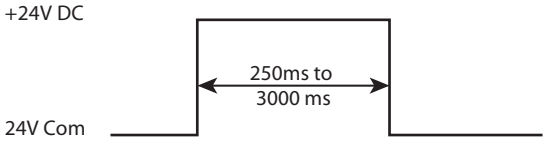
The reset block is used in safety functions requiring a manual intervention to turn the safety system on.

Figure 51 - Reset Function Block



To prevent inadvertent actuation of the reset block, the reset requires a leading edge and trailing edge within a specific timeframe. The pulse width must be between 250...3000 ms. If the pulse width is too short or too long, the reset function will not be executed.

Figure 52 - Reset Timing



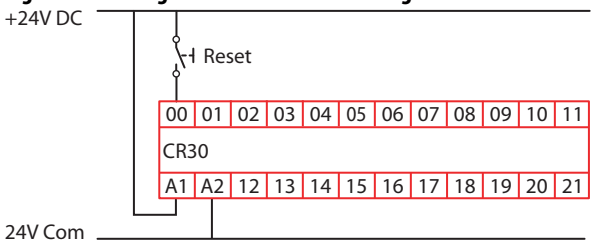
The reset block is a Safety Monitoring Function in the CCW. The user must specify an input and input filtering.

The reset input signal can come from either one input wiring terminal or over the Modbus communication input. The available input selections are:

- EI_00...EI_11 (Embedded Input Terminals 00...11)
- MP_12...MP_17 (Multi-Purpose Terminals 12...17)
- P1_00...P1_03 (Plug-In 1 Terminals 00...03)
- P2_00...P2_03 (Plug-In 2 Terminals 00...03)
- SP_00...SP_15 (Modbus Inputs 00...15)

The user can use the default Input Filter or choose to modify this setting.

Figure 53 - Wiring Connection for a Reset Signal to Terminal 00



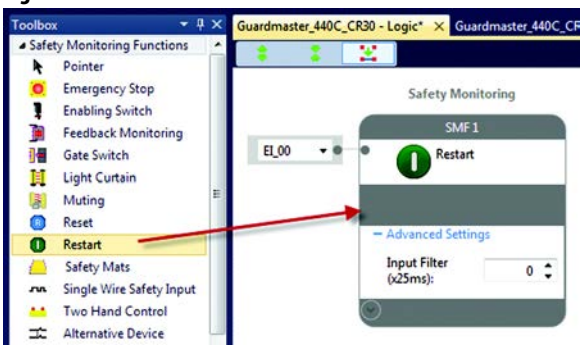
The reset block works in conjunction with one or more output blocks. When an output block requires a manual reset, the CCW will show all the available reset inputs that can be used.

Restart

The restart function works in conjunction with an AND or OR logic block in Logic Level A and Logic Level B. When all the inputs are satisfied, exercising the restart input will cause the restart function go be effective. If the Restart function is already effective, the Restart input has no affect.

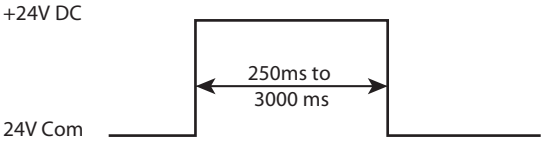
The Restart can only be used with one AND or OR logic block.

Figure 54 - Restart Function Block



The Restart Function requires a leading edge and trailing edge within a specific timeframe. The pulse width must be between 250...3000 ms. If the pulse width is too short or too long, the Restart function will not be executed.

Figure 55 - Restart Timing

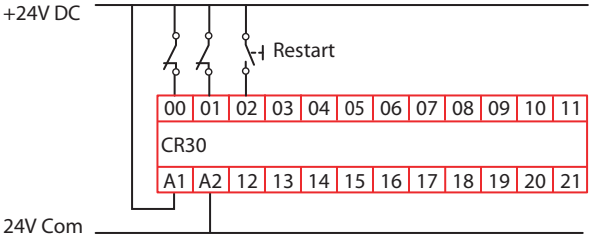


The available input selections for the Restart are:

- EI_00...EI_11 (Embedded Input Terminals 00...11)
- MP_12...MP_17 (Multi-Purpose Terminals 12...17)
- P1_00...P1_03 (Plug-In 1 Terminals 00...03)
- P2_00...P2_03 (Plug-In 2 Terminals 00...03)
- SP_00...SP_15 (Modbus Inputs 00...15)

The user can use the default Input Filter or choose to modify this setting.

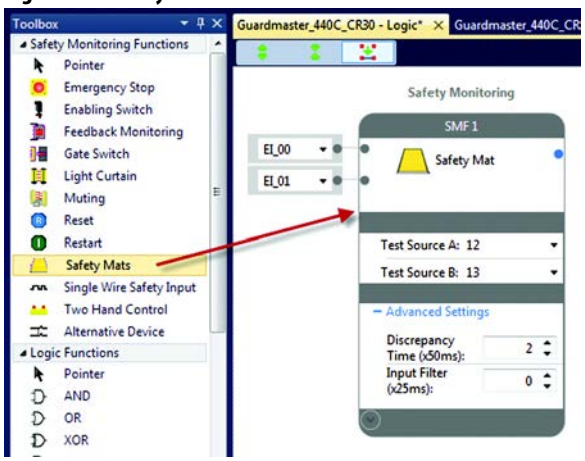
Figure 56 - Wiring Connection for a Restart Signal to Terminal 02 with Inputs on Terminals 00 and 01



Safety Mat

Four wire safety mats can be connected to the CR30. The 4 wires create two channels. Stepping on the safety mat creates a short circuit between channel 1 and 2. To detect the short circuit, input pulse testing is used. The mats must be connected to the input test pulses.

Figure 57 - Safety Mat Function Block



The safety mat can be connected to the following terminals:

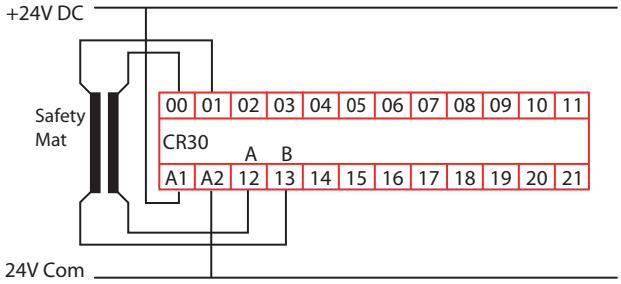
- EI_00...EI_11 (Embedded Input Terminals 00...11)
- MP_12...MP_17 (Multi-Purpose Terminals 12...17)

The user can use the default Discrepancy Time and Input Filter or choose to modify these settings.

For input test pulses, terminals 12...17 are available. The CCW automatically selects a different test pulse pattern for each input.

An example schematic shows a safety mat connected to terminals 0 and 1. The mat uses test pulses generated at terminals 12 and 13.

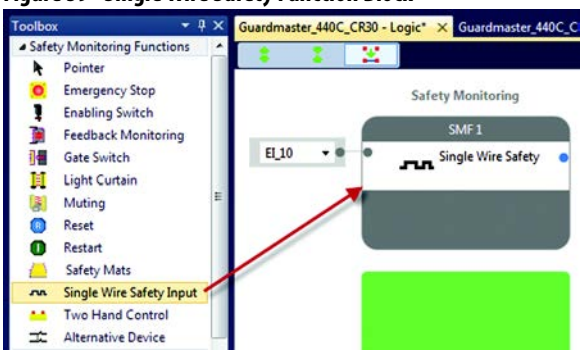
Figure 58 - Example Schematic for a Safety Mat



Single Wire Safety Input

When configured for this type of input, the CR30 expects a Single Wire Safety (SWS) input signal from a GSR relay or a safeguarding device that has a SWS output signal. The GSR relay family includes the CI, SI, DI, DIS, GLP, GLT, EM, and EMD modules. Each of these modules provides the SWS signal on terminal L11.

Figure 59 - Single Wire Safety Function Block

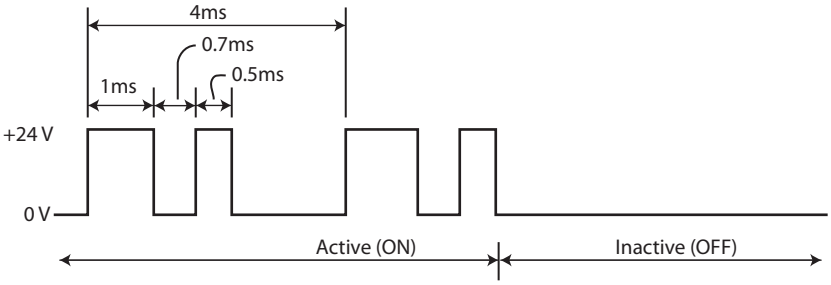


Only terminals 10 and 11 of the CR30 can be configured to receive the SWS signal.

- EI_10...EI_11 (Embedded Input Terminals 10...11)

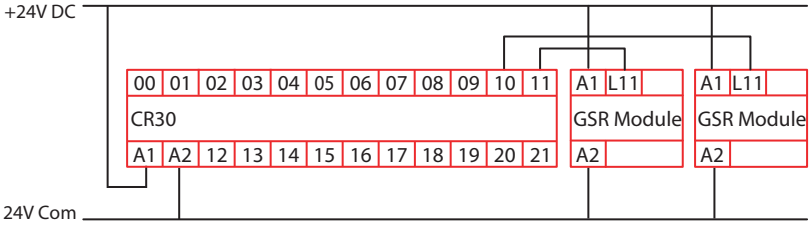
The SWS signal is a long pulse followed by a short pulse, which is repeated while the signal is active. The SWS is active when the safety outputs of a GSR safety relay are ON. When the SWS is inactive, the SWS signal is 0V. The timing and voltage characteristics of the SWS waveform are shown below.

Figure 60 - SWS Waveform



An example schematic of the connection of the SWS from other modules in the GSR family of relays. The CR30 and GSR modules must be connected to the same 24V Common.

Figure 61 - SWS Connection Schematic



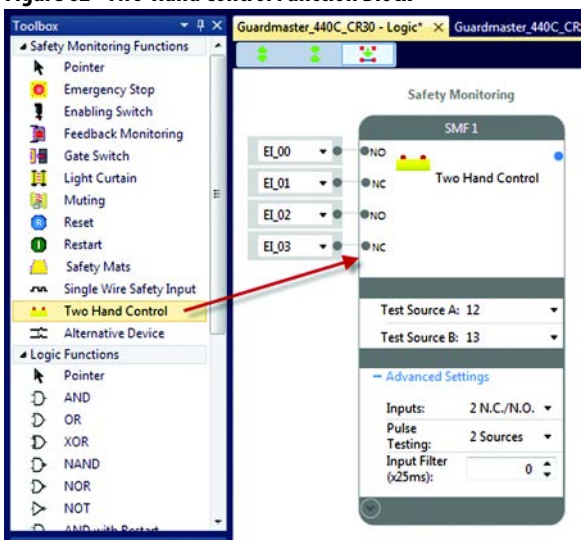
Two-Hand Control

The CR30 can be configured to operate in two different types of two-hand control, which are specified in ISO 13851. The two types are:

- Type IIIA (for low risk safety systems)
- Type IIIC (for high risk safety systems)

Mechanically palm-operated buttons (like the Bulletin 800R) or the electronic output push buttons (like the Bulletin 800Z Zero Force Touch buttons) should be used as actuating devices for two hand control. The CR30 requires two buttons to be actuated simultaneously and maintained to turn the two-hand safety monitoring function ON. To meet the simultaneity requirement, the two buttons must be actuated within 500 ms of each other.

Figure 62 - Two-Hand Control Function Block



The two-hand controls can be connected to the following terminals.

- EI_00...EI_11 (Embedded Input Terminals 00...11)
- MP_12...MP_17 (Multi-Purpose Terminals 12...17)

The user can use the default Input Filter or choose to modify these settings.

When test pulses are used, the CCW automatically selects a different test pulse pattern for each input. The two-hand control can use input test pulses from following terminals:

- MP_12...MP_17 (Multi-Purpose Terminals 12...17)

Type IIIA Two-hand Control

The Type IIIA uses only one normally open contact for each hand. This configuration can be set up with or without the use of test pulses. The test pulses provide short circuit fault detect between channels and between channel and 24V.

Figure 63 - Example Wiring Connection for a Type IIIA Two-Hand Control without Test Pulses

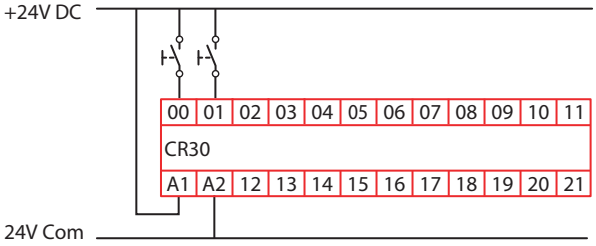
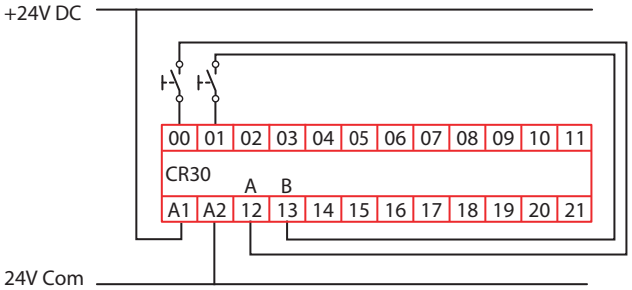


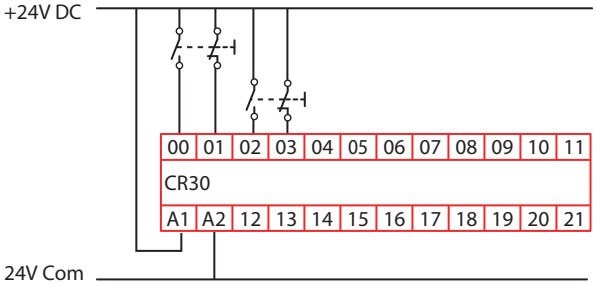
Figure 64 - Wiring Connection for a Type IIIA Two-Hand Control with the Test Pulses



Type IIIC Two-Hand Control

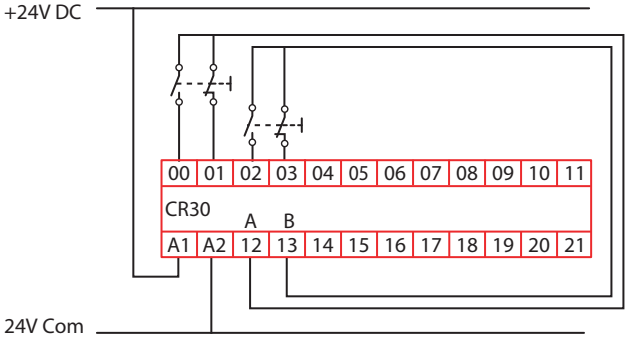
The Type IIIC uses a normally open and a normally closed contact for each hand.

Figure 65 - Example Wiring Connection for a Type IIIC Two-Hand Control without Test Pulses



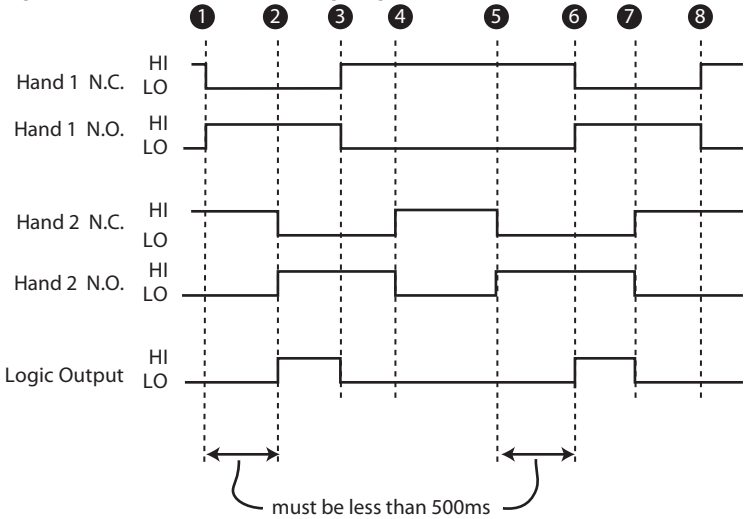
When test pulses are used, the CR30 will detect a short from Channel 1 to Channel 2 after 3.7 seconds and turn the output OFF. To clear the fault, release the both buttons.

Figure 66 - Wiring Connection for a Type IIIC Two-Hand Control with Test Pulses



The timing diagram for the two-hand control is shown below. The Type IIIA uses only the N.O. contact of the button. The Type IIIC uses both the N.C. and the N.O. contacts.

Figure 67 - Two-Hand Control Timing Diagram



	Description
1	Hand 1 button is pressed.
2	Hand 2 button must be pressed within 500 ms for the output logic to turn ON.
3	Releasing either hand button causes the logic output to turn off.
4	Both hand buttons must be released to start a new cycle.

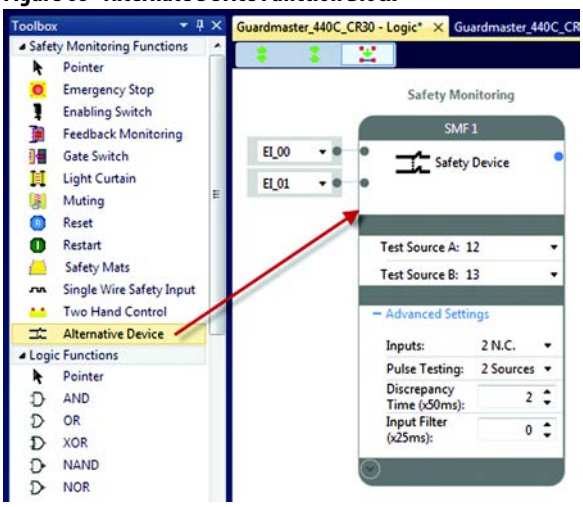
	Description
5	Hand 2 button is pressed.
6	Hand 1 button must be pressed within 500 ms for the output logic to turn ON.
7	Releasing either hand button causes the logic output to turn off.
8	Both hand buttons must be released to start a new cycle.

Alternate Device

The Alternate Device provides the flexibility to create other types of input monitoring blocks. Use this block for the following types of input functions:

- Single Channel OSSD
- Single Channel N.C.
- Dual Channel OSSD
- Dual Channel 2 N.C.
- Dual Channel 1 N.C./1 N.O.
- Three Channel N.C.
- Three Channel OSSD

Figure 68 - Alternate Device Function Block



Single Channel

Single channel safety monitoring functions require only one connection to an input terminal. The single channel input must only be used in low risk safety systems.

The available input terminals are:

- EI_00...EI_11 (Embedded Input Terminals 00...11)
- MP_12...MP_17 (Multi-Purpose Terminals 12...17)

The user can use the default Input Filter or choose to modify this setting.

When test pulses are used, the CCW automatically selects the test pulse pattern. The single channel N.C. can use input test pulses from following terminals:

- MP_12...MP_17 (Multi-Purpose Terminals 12...17)

Figure 69 - Example Schematic for Single Channel N.C. without Test Pulse

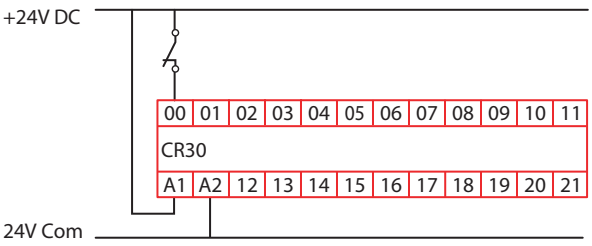


Figure 70 - Example Schematic for Single Channel N.C. with Test Pulse

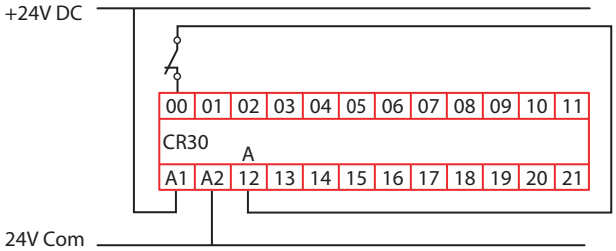
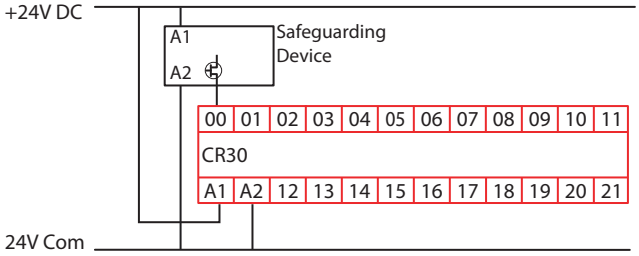


Figure 71 - Example Schematic for Single Channel OSSD



Dual Channel

Dual Channel safety monitoring functions require two independent circuit connections to the CR30. Dual channel inputs are used for medium and high risk applications.

The user can modify the number and types of inputs:

- 2 N.C.
- 2 OSSD
- 1N.C./1 N.O.

The available input selections for the Dual Channel OSSD and 2 N.C. inputs are:

- EI_00...EI_11 (Embedded Input Terminals 00...11)
- MP_12...MP_17 (Multi-Purpose Terminals 12...17)

The available input selections for the N.O. contact are:

- MP_12...MP_17 (Multi-Purpose Terminals 12...17)

Pulse testing can be set to 1 Source, 2 Sources or Disabled. When 1 or 2 Sources is selected, the next available test sources are automatically assigned by the CCW. The user can modify the sources afterward.

The user can use the default Discrepancy Time and Input Filter or choose to modify these settings.

The two terminals do not necessarily have to be consecutive.

Figure 72 - Example Schematic for 2 N.C. Without Test Pulse

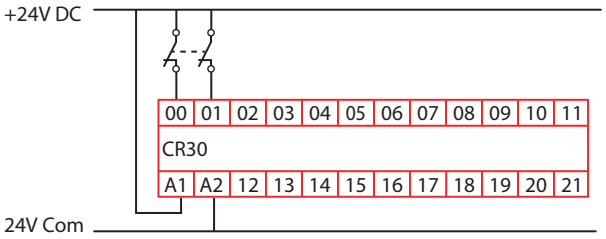
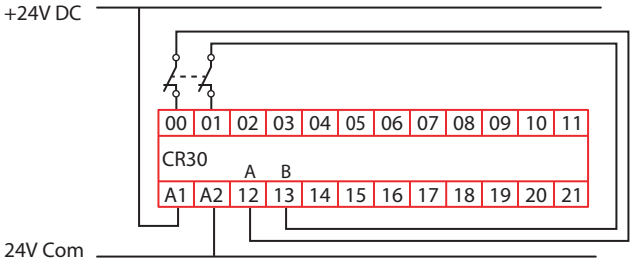


Figure 73 - Example Schematic for 2 N.C. With Two Test Pulses Sources



Dual Channel OSSD

Safeguarding devices with OSSD outputs generate their own test pulses to detect for short circuit conditions or have other methods of detecting short circuit conditions. When configured for dual channel OSSD, the CR30 will ignore the test pulses.

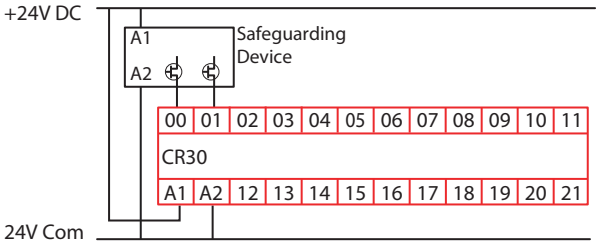
Examples of products that use dual channel OSSD outputs are listed below:

Table 7 - Products Using Dual Channel OSSD Outputs

Product Types	Product Name
Light Curtains	GuardShield
Laser Scanners	Safezone, Safezone Multizone
Gate Interlocks	SensaGuard, SensaGuard with Integrated Latch
Guardlocking Interlocks	TLS-ZR, 440G-LZ

Short circuits are detected by the safeguarding device, and the safeguarding device turns off its safety outputs. Devices with OSSD outputs are usually capable of operating in high risk applications.

Figure 74 - Example Schematic for Two OSSD



Dual Channel N.C./N.O.

The N.C./N.O. configuration applies the diversity concepts, where one contact is open and the other contact is closed. The contact, while in an open state, cannot be welded closed. The CR30 turns off its safety outputs when either channel changes state. Both channels must change state for proper performance.

Figure 75 - Example Schematic for N.C./N.O. Without Test Pulse

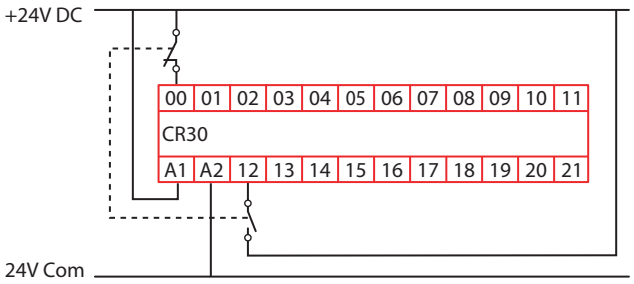


Figure 76 - Example Schematic for N.C./N.O. With One Test Pulse

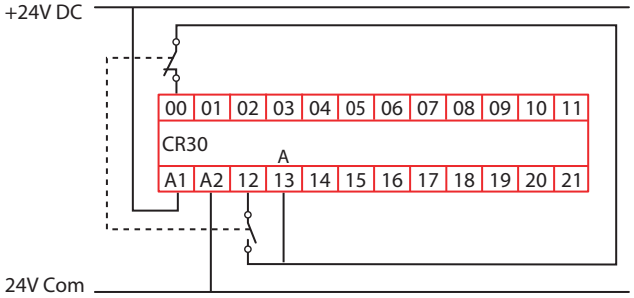
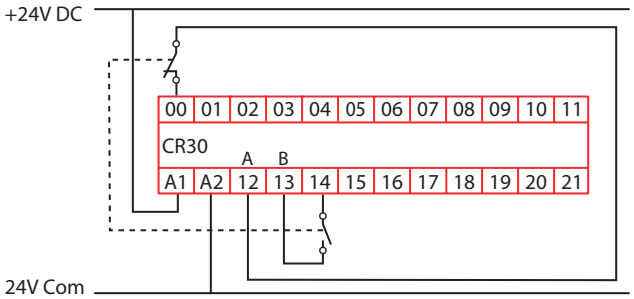


Figure 77 - Example Schematic for N.C./N.O. With Two Test Pulses



If a short circuit occurs on terminal 12 to 24V, the CR30 will turn off its safety outputs within 35 ms. Remove the fault and cycle the contacts to clear the fault.

If a short circuit occurs on terminal 12 to ground, the CR30 will turn off its safety outputs within 3.3 seconds. Remove the fault and cycle the contacts to clear the fault.

If a short circuit occurs from terminal 12 to terminal 13, the CR30 will turn off its safety outputs within 35 ms. Remove the fault and cycle the contacts to clear the fault.

Three Channel

The CR30 has the capability of accepting three channels into one safety monitoring function. All three inputs must be HI to satisfy the input. If any one of the inputs goes LO, the output of safety monitoring function goes LO and turns off its associated output devices. The three N.C. can be operated without input test pulses, with one input test pulse, with only two input test pulses or with three input test pulses.

The available input selections for the three channel inputs are:

- EI_00...EI_11 (Embedded Input Terminals 00...11)
- MP_12...MP_17 (Multi-Purpose Terminals 12...17)

Pulse testing can be set to 1 Source, 2 Sources, 3 Sources, or Disabled. When 1, 2, or 3 Sources is selected, the next available test sources are automatically assigned by the CCW. The user can modify the sources afterward.

The user can use the default Discrepancy Time and Input Filter or choose to modify these settings.

The three terminals do not necessarily have to be consecutive.

Figure 78 - Example Schematic for Three N.C. Without Test Pulses

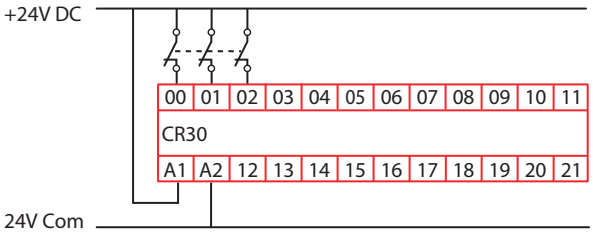


Figure 79 - Example Schematic for Three N.C. With 1 Test Pulse Source

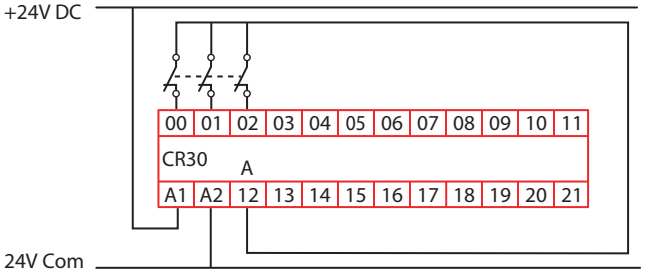


Figure 80 - Example Schematic for Three N.C. With 3 Test Pulse Sources

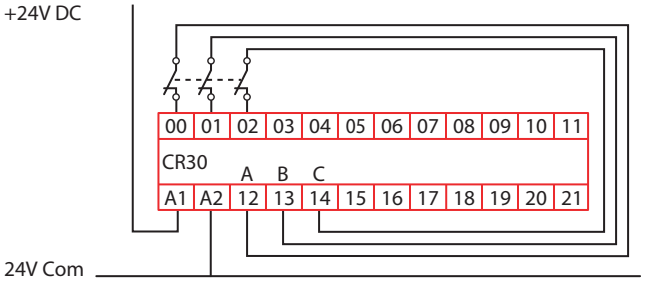
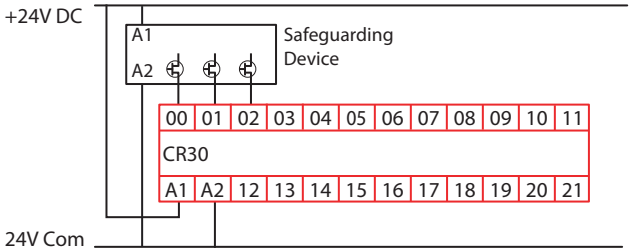


Figure 81 - Example Schematic for 3 OSSD

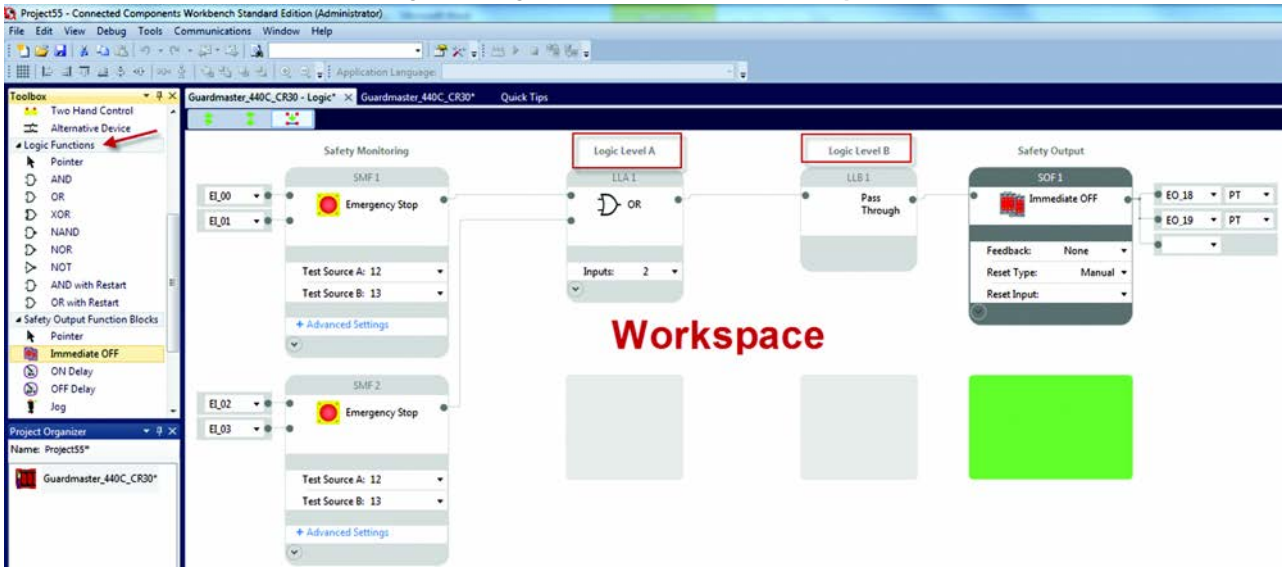


Notes:

Logic Levels A and B

The CCW has two levels that allow the user to apply simple logic to create more sophisticated safety systems. The logic levels are labeled A and B on the CCW workspace. The logic functions are available in the Toolbox.

Figure 82 - Logic Levels A and B on the CCW Workspace



Pass Through

When a logic level is not used, the CCW automatically creates a Pass Through block.

AND

The AND block accepts 2...24 inputs. When all the inputs are HI, the output of the block is HI. If any of the inputs is LO, the output of the block is LO.

The AND block is often used when multiple e-stops must be released and multiple safety gates must be closed for the safety system to be energized.

Figure 83 - AND Logic Block

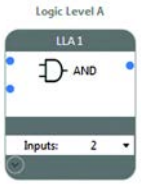


Table 8 - AND Logic Table for 2 Inputs

Input 1	Input 2	Output
0	0	0
0	1	0
1	0	0
1	1	1

OR

The OR block accepts 2...24 inputs. If any of the inputs are HI, the output of the block is HI. If all of the inputs go LO, the output of the block goes LO.

The OR block is often used with Enabling devices.

Figure 84 - OR Logic Block

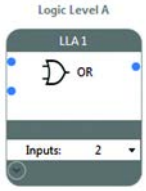


Table 9 - OR Logic Table for 2 Inputs

Input 1	Input 2	Output
0	0	0
0	1	1
1	0	1
1	1	1

XOR

The XOR block accepts 2...24 inputs. The output of the XOR block is HI when any input is HI. The output is LO when more than one input is HI or if all inputs are LO.

Figure 85 - XOR Logic Block

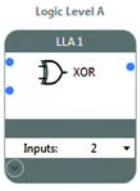


Table 10 - XOR Logic Table for 2 Inputs

Input 1	Input 2	Output
0	0	0
0	1	1
1	0	1
1	1	0

NAND

The NAND block accepts 2...24 inputs. The NAND performs the opposite of an AND block. The output of the NAND block is LO when all the inputs are HI. When any input is LO, the output is HI.

Figure 86 - NAND Logic Block

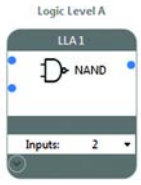


Table 11 - NAND Logic Table for 2 Inputs

Input 1	Input 2	Output
0	0	1
0	1	1
1	0	1
1	1	0

NOR

The NOR block performs the opposite of the OR block. When any input is HI, the output is LO. When all the inputs are LO, the output is HI.

Figure 87 - NOR Logic Block

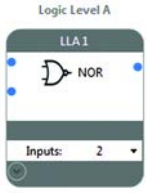


Table 12 - NOR Logic Table for 2 Inputs

Input 1	Input 2	Output
0	0	1
0	1	0
1	0	0
1	1	0

NOT

The NOT block accepts only 1 input. The NOT inverts the input signal. When the input is LO, the output is HI. When the input is HI, the output is LO.

Figure 88 - NOT Logic Block

Table 13 - NOT Logic Table for 2 Inputs

Input	Output
0	1
1	0

AND with Restart

The AND with Restart accepts 2...24 inputs and requires a Restart input. All the inputs must be HI when the Restart button is pressed.

The CCW automatically recognizes the Restart function blocks and allows the user to select one. Once selected, the Restart is no longer available for other logic blocks.

The figure below shows an example with a gate switch and a light curtain. Both the gate must be closed and the light curtain clear. Then, the Restart input must be pressed. The output of the logic block goes HI on the trailing edge of the restart signal.

Figure 89 - Example of AND with Restart

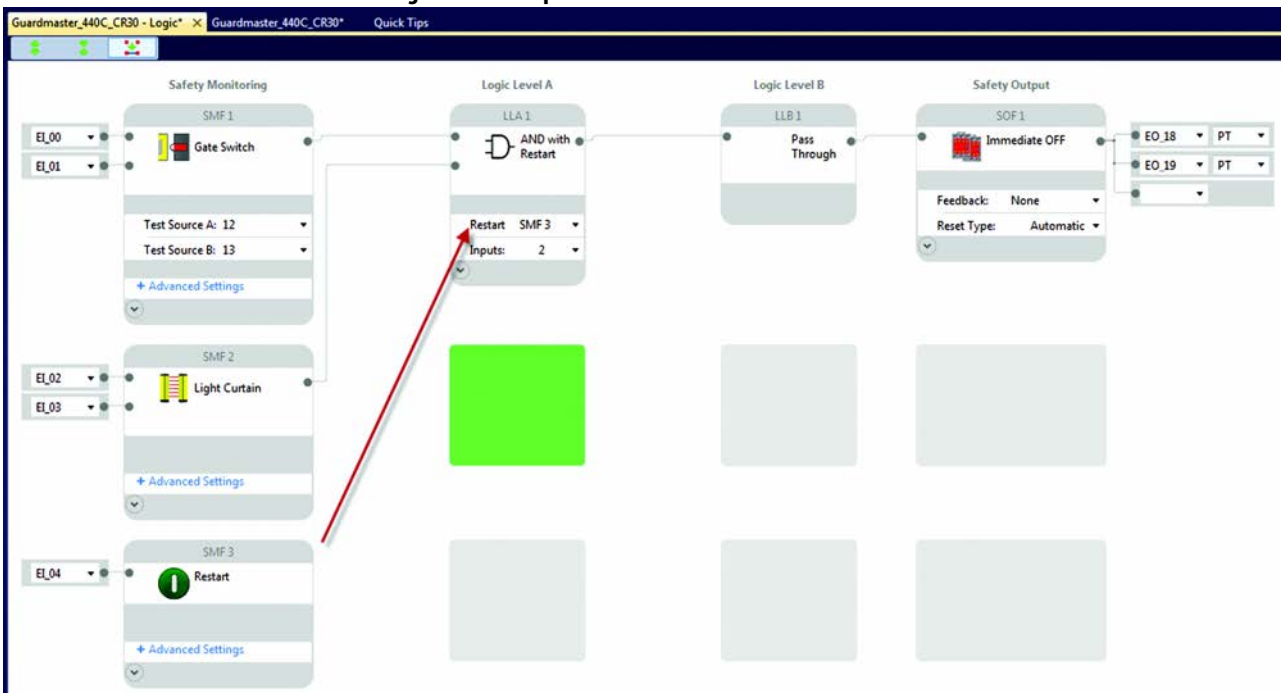
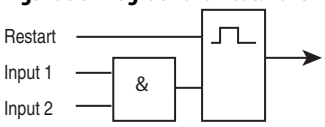
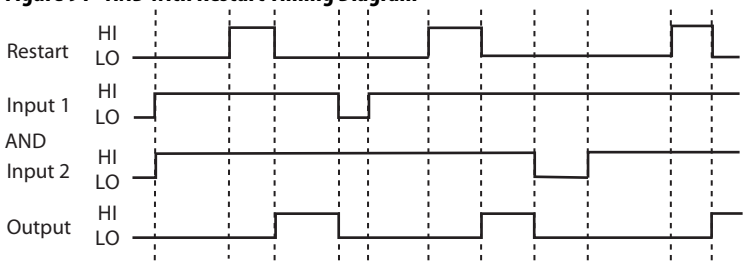


Figure 90 - Logic of the Restart Function with 2 input AND



The timing diagam shows how the output of the Logic block responds to the input signals and the Restart signal. Both inputs must be HI when the Restart signal occurs fot the output to go HI. If any of the inputs go LO, the output will go LO.

Figure 91 - AND with Restart Timing Diagram



OR with Restart

The OR with Restart accepts 2...24 inputs and requires a Restart input. At least one input must be HI when the Restart button is pressed.

The CCW automatically recognizes the Restart function blocks and allows the user to select one. Once selected, the Restart is no longer available for other logic blocks.

The figure below shows an example with a gate switch and a light curtain. Either the gate must be closed or the light curtain clear. Then, the Restart input must be pressed. The output of the logic block goes HI on the trailing edge of the restart signal.

Figure 92 - Example OR with Restart

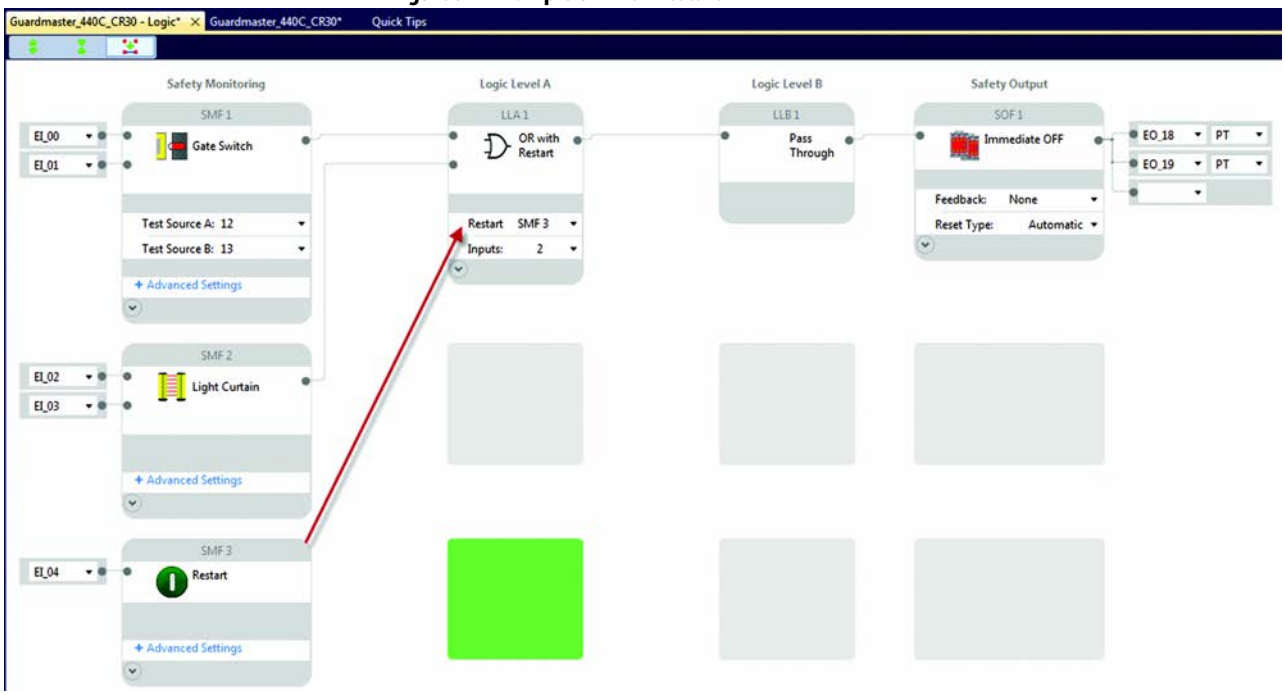
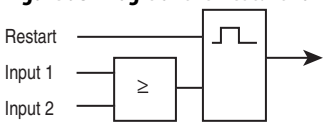
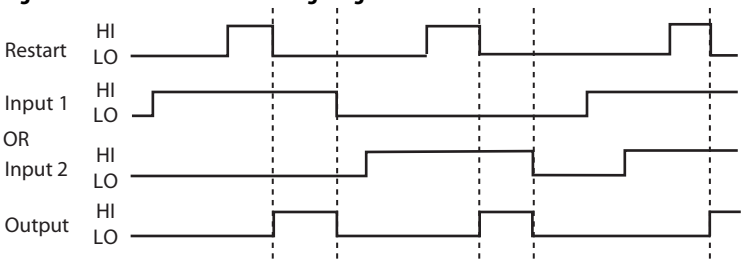


Figure 93 - Logic of the Restart Function with 2 input OR



The timing diagram shows how the output of the Logic block responds to the input signals and the Restart signal. Either or both inputs can be HI when the Restart signal occurs for the output to go HI. If all of the inputs go LO, the output will go LO.

Figure 94 - OR with Restart Timing Diagram



Safety Outputs

The safety output blocks are the fourth stage of the configuration. Many of the blocks have common features.

Input Connection

Each output block has one input connection. This input connection can be connected to only Logic Level B blocks.

Feedback

The Immediate OFF, ON Delay and OFF Delay blocks have a feedback parameter. To use the feedback parameter, a feedback input block must be declared. If a feedback input block is not available, the feedback parameter will be set to "None", and can be considered to be always HI.

Reset

The reset parameter must be set to either automatic or manual.

- If set to automatic, the output will turn on when the input received from the Logic Level B block is HI.
- If the reset is set to manual, a reset input block must be declared. Before the reset button is pressed, the input received from the Logic Level B block must be HI. Then the output will turn on if the reset button must be pressed and held for at least 0.25 s and released within 3 s.

Timing

Timing is used in the ON Delay, OFF Delay, and Jog functions.

The timing can be set between 50...300,000 ms (5 minutes) in 50 ms increments.

Output Connections

The output of the block can be connected to one or more of the following wiring terminals:

- 12...17 Multi-Purpose (MP)
- 18...21 Embedded Output (EO)
- 00...03 Plug-in 1 Module (not safety rated)
- 00...03 Plug-in 2 Module (not safety rated)

The multipurpose outputs can be configured to operate with pulse test (PT) or without test pulses (No PT). The embedded terminals always operate with test

pulses. Terminals 20 and 21 can be configured as Single Wire Safety (SWS) output.

WARNING: The plug-in outputs must only be used for non-safety rated purposes.

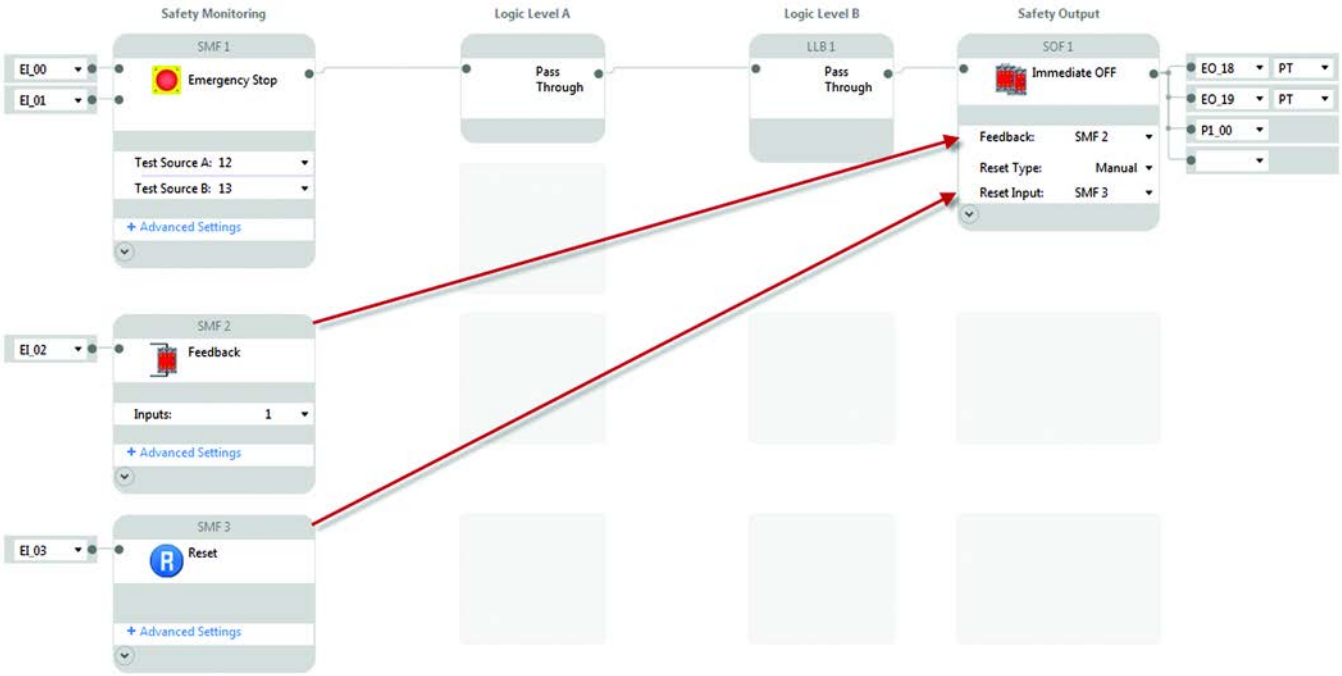
Immediate OFF

The Immediate OFF block is used to turn output terminals off immediately upon a demand placed on a safety function.

The example configuration below shows the Immediate OFF output block connected to an e-stop block through Logic Level LLB1. The feedback signal is provided by SMF2 and manual reset by SMF3. The output is connected to:

- Terminals 18 and 19 for dual channel safety switching of the machine hazard(s).
- Plug-in 1 terminal 00 for status indication.

Figure 95 - Immediate OFF Configuration



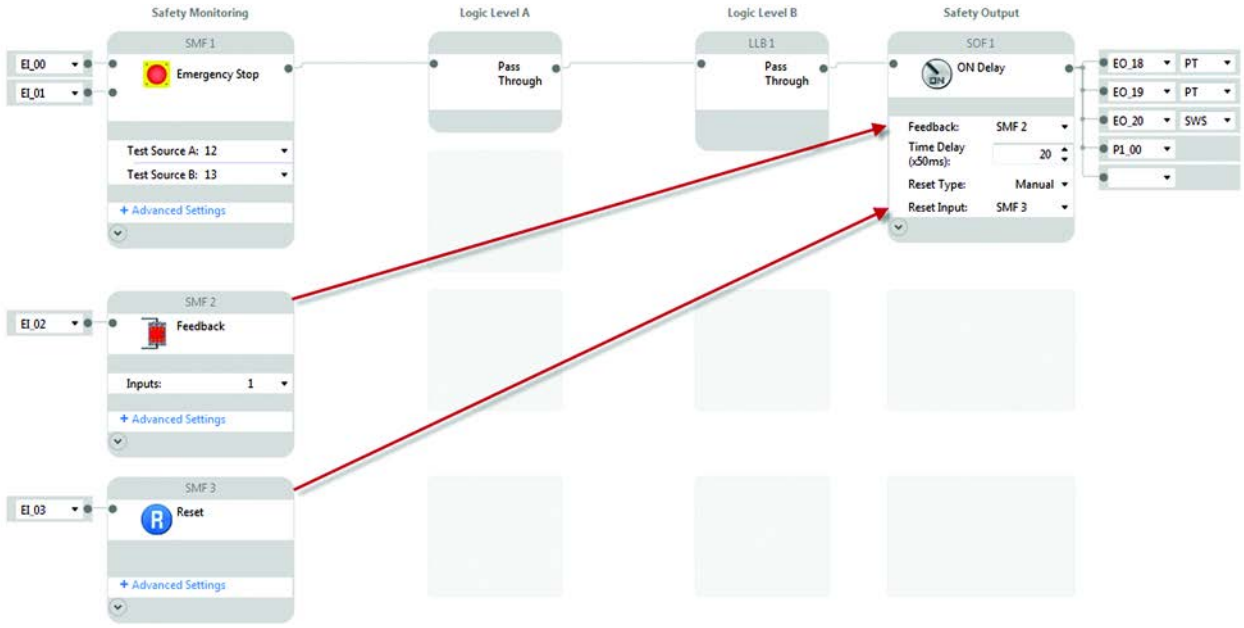
ON Delay

The ON Delay block turns on the output after the specified time delay expires.

The example configuration below shows the ON Delay output block connected to an e-stop block through Logic Level LLB1. The feedback signal is provided by SMF2 and manual reset by SMF3. The time delay is set to 20. The output will turn on 1000 ms (20x50 ms) after the reset button is released. The output is connected to:

- Terminals 18 and 19 for dual channel safety switching of the machine hazard(s).
- Terminal 20, which is configured as a Single Wire Safety (SWS) output.
- Plug-in 1 terminal 00 for status indication.

Figure 96 - ON Delay Configuration



OFF Delay

The OFF Delay block turns off the output after the specified time delay expires.

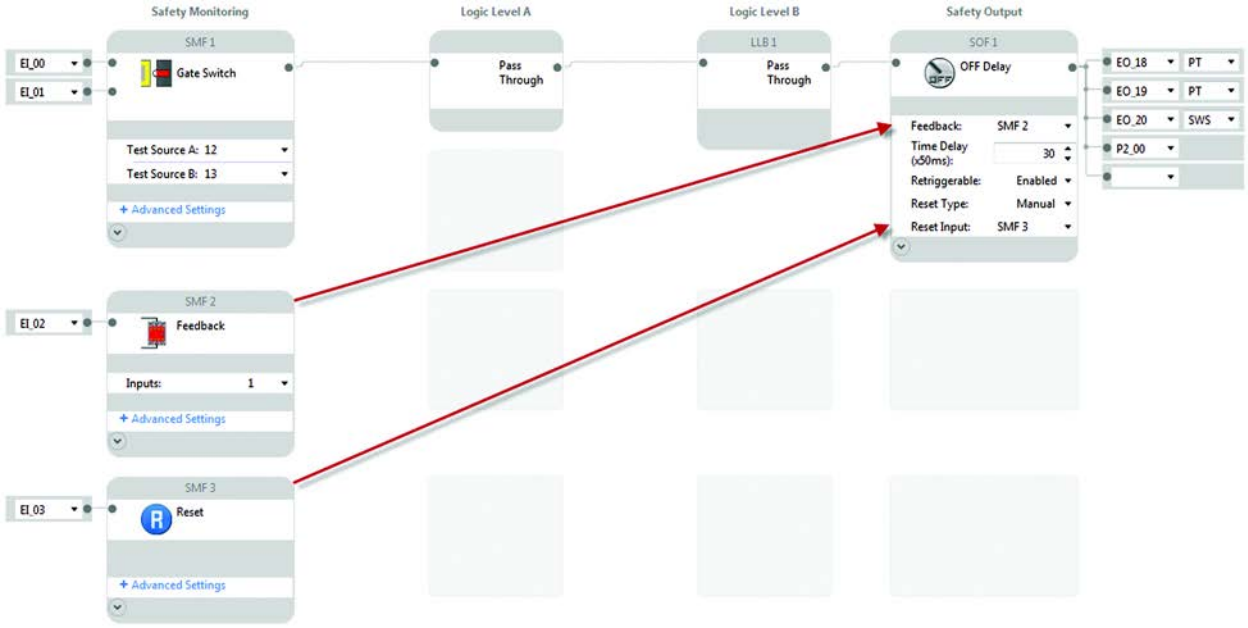
The retriggerable parameter can be set to enabled or disabled.

- When enabled, the input to the OFF Delay block can go HI again during the timing cycle, and the output will remain HI.
- When disabled, the timing cycle runs to completion, regardless of changes to the input.

The example configuration below shows the OFF Delay output block connected to a gate switch block through Logic Level LLB1. The feedback signal is provided by SMF2 and manual reset by SMF3. The time delay is set to 30. The output will turn off 1500 ms (30x50 ms) after the gate is opened. The output is connected to:

- Terminals 18 and 19 for dual channel safety switching of the machine hazard(s).
- Terminal 20, which is configured as a Single Wire Safety (SWS) output.
- Terminal 00 of Plug-in 2 for status reporting

Figure 97 - OFF Delay Configuration



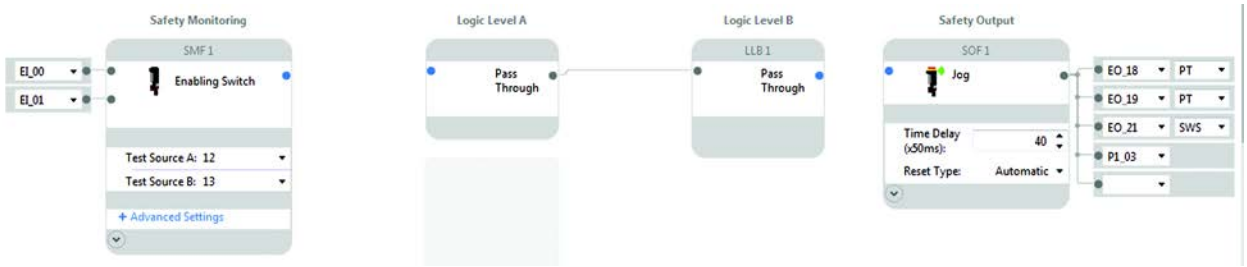
Jog

The Jog block turns on the output for a specified duration while the jog input is held HI. If the Jog input goes LO, the output immediately turns off.

The example configuration below shows the Jog output block connected to an enabling switch block through Logic Level LLB1. The reset is set to automatic. The time delay is set to 40. The output will turn on for a maximum of 2000 ms (40x50 ms) after the enabling switch is closed. The output is connected to:

- Terminals 18 and 19 for dual channel safety switching of the machine hazard(s).
- Terminal 20, which is configured as a Single Wire Safety (SWS) output.
- Plug-in 1 terminal 03 for status indication.

Figure 98 - Jog Configuration



Muting Lamp

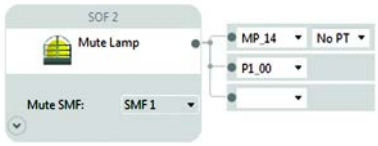
The Muting Lamp block works in conjunction with the Muting safety monitoring function.

The muting lamp is not monitored. If the lamp burns out or becomes disconnected, the muting function continues to function properly.

The example configuration below shows the muting lamp output block connected to the mute function in SMF1. The output is connected to:

- Terminal 14, a multi-purpose terminal with no pulse testing (No PT).
- Plug-in 1 terminal 00 for additional status indication.
- The muting lamp should be connected to terminals without pulse testing. Filament lamps will not be affected by pulse testing, but LED lamps may appear to flicker if pulse testing is enabled.

Figure 99 - Muting Lamp Configuration



Notes:

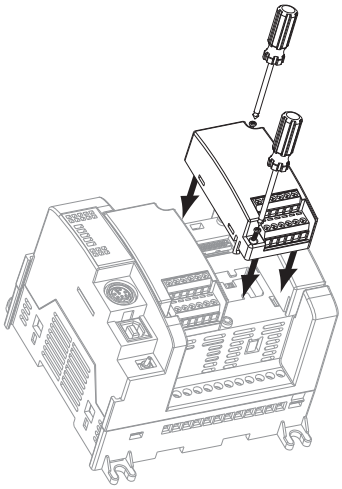
Plug-in Modules

The CR30 accepts up to two Plug-in I/O Modules. The CR30 only accepts the 2080-IQ4OB4 module. The input and output signals of these modules are not safety rated. They must only be used for standard control functions.

Insert Module into Controller

Follow the instructions to insert and secure the plug-in module to the controller.

Figure 100 - Plug-In Module



1. Position the plug-in module with the terminal block facing the front of the controller as shown.
2. Snap the module into the module bay.
3. Using a screwdriver, tighten the 10...12 mm (0.39...0.47 in.) M3 self-tapping screw to 0.2 N•m (1.48 lb•in) torque.

2080-IQ40B4

The 2080-IQ4OB4 has four sinking inputs and four sourcing outputs. The COM connection B3 is internally connected to A3. This COM connection is for the inputs (without it, the inputs will not turn on). Terminal B4 must be connected to the +24V supply and Terminal A4 must be connected to 24V Common to provide power to the outputs terminals O-00...O-03.

Figure 101 - 2080-IQ4OB4 Schematic Showing Four Standard Input Signals

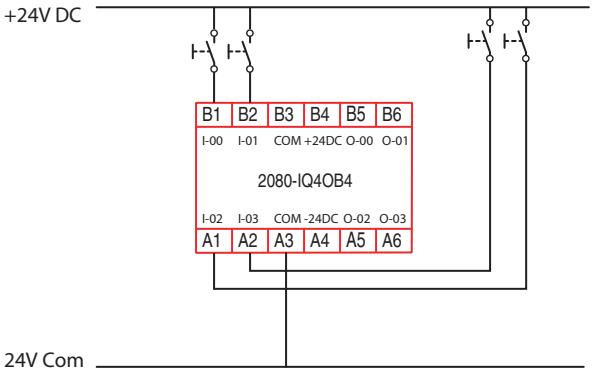
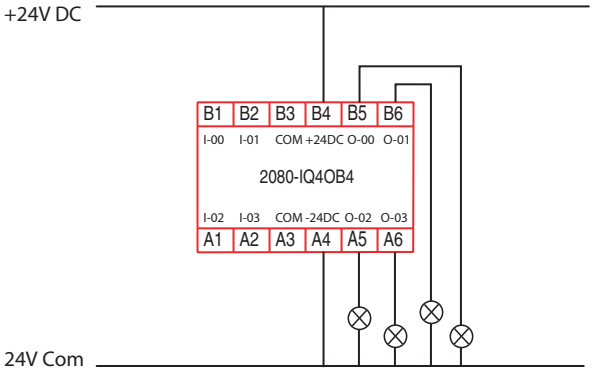


Figure 102 - 2080-IQ4OB4 Schematic Showing Four Standard Output Signals

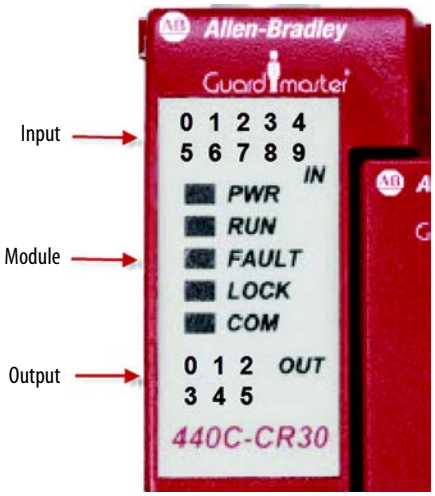


LEDs

The CR30 has 21 LEDs on the upper left front of the module. These 21 LEDs fall into three categories:

- Input status
- Module status
- Output status

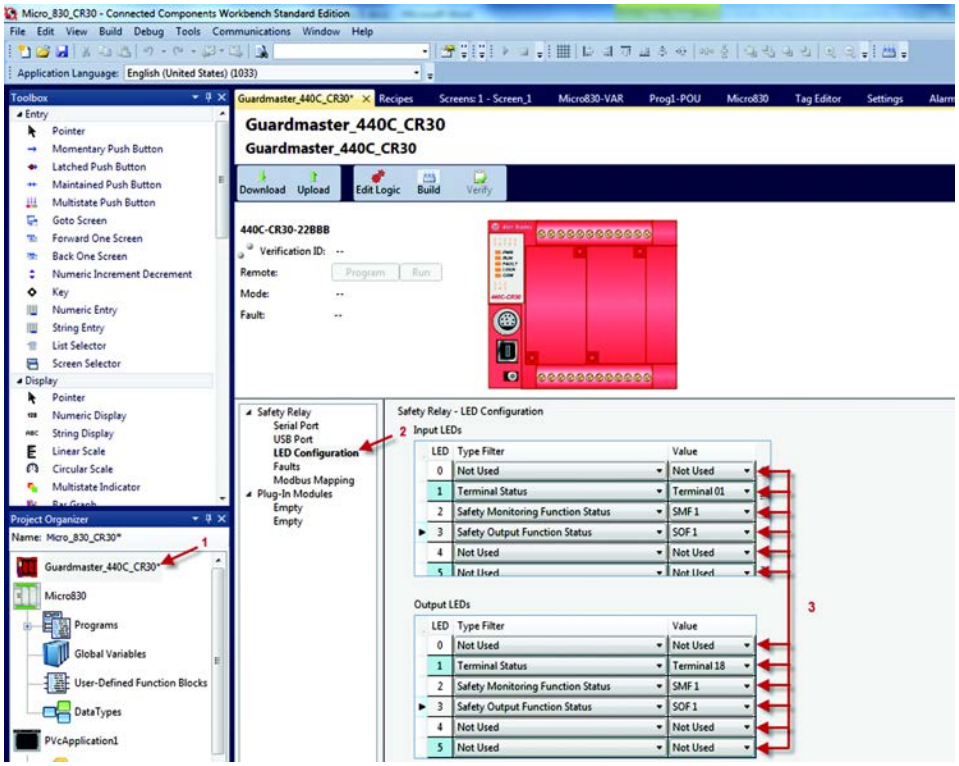
Figure 103 - LEDs



Input and Output LEDs

To access and configure the LEDs in the CCW,

1. In the Project Organizer, double click on **Guardmaster_440C-CR30***.
2. Click on **LED Configuration**.
3. Configure the filter type and value for input and output LEDs.



First select one of four Filter Types for each LED:

1. Not Used
2. Terminal Status
3. Safety Monitoring Function Status
4. Safety Output Function Status

Then select the instance for each Filter Type.

Monitoring a function is advantageous when the input and output logic blocks have multiple inputs or outputs. A single LED can provide status information about multiple inputs or outputs, when it provides the status of an input or output block.

In the previous example:

a. Input LED 1 is monitoring a terminal status. In this case, it is monitoring terminal 01. When the signal to terminal 1 is HI, the LED is on. When the signal to terminal 1 is LO, the LED is off. If this were a single channel input, then the LED provides all the information we need to know about the input.

b. Input LED 2 is monitoring safety monitoring function 1. If the LED is on, then we know that all the inputs are satisfied for whatever function (e.g., dual channel input, muting, or two-hand control) is being monitored.

c. Output LED 3 is monitoring the status of a Safety Output Function. In this case, SOF 1 is being monitored. If SOF 1 is driving four outputs (two safety, one diagnostic, and one Modbus), we expect all four outputs to be HI when LED 3 is on.

Controller Status LEDs

The CR30 has five module status LEDs that are described in the table below.

Table 14 - Status LEDs

LED	Color	Indicates
POWER	Off	No input power or power error condition
	Green	Power on
RUN	Off	Program mode
	Green	Run mode
	Flashing Green [2 Hz]	Application is running but not verified
FAULT	Off	No fault detected
	Red Flashing [2 Hz]	Application fault detected, recoverable
	Red	Controller hardware faulted, non-recoverable
LOCK	Off	Not used
COM	Off	No communications
	Green	Communications by serial port or USB

Notes:

Modbus Communications

The CR30 uses Modbus RTU communications to transfer status information and control signals to Micro 800 controllers and human-machine interfaces like the Allen-Bradley PanelView.

The Modbus configuration of the CR30 is fixed to Modbus RTU slave at address 1.

For more information on PanelView, refer to the following documents:

- User Manual: 2711C-UM001_-EN-P
- Quick Start Guide: 440C-QS001_-EN-P

Modbus Mapping

The CR30 Modbus addresses are mapped to parameters shown in the table below. The addresses in the range of 1...512 can be accessed as coils. The fault log can be accessed by holding register reads; each address contains 16 bits of data.

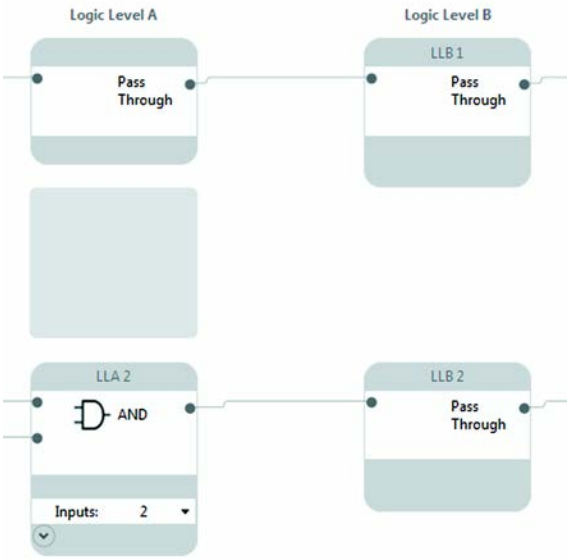
Table 15 - Modbus Addresses

Modbus Address	Parameter
000001 - 000016	Modbus serial input data
000025 - 000028	Input Data for Plug-in 1 Terminals I-00 - I-03
000033 - 000036	Output Data for Plug-in 1 Terminals O-00 - O-03
000265	Processor HW fault
000266	Safety Input HW fault
000267	Safety Output HW fault
000268	Power supply fault / Main transistor fault
000269	Communication fault
000270	Configuration fault (wrong revision, invalid configuration)
000271	Time out (Clock monitoring)
000272	Plug-in fault
000273 - 000292	State of Embedded Terminals 00 - 21
000297 - 000300	Input of Plug-in 2 Terminals I-00 - I-03
000301 - 000304	Output of Plug-in 2 Terminals O-00 - O-03
000305 - 000328	State of Safety Monitoring Function (SMF) 0 - 23
000329 - 000344	State of Logic Level A Instance (LLA) 0 - 15 ❶
000345 - 000360	State of Logic Level B Instance (LLB) 0 - 15

Modbus Address	Parameter
000361 - 000376	State of Safety Output Function (SOF) 0 - 15
000377 - 000392	Ready-to-start of SOF 00 - 15
000393 - 000416	Fault bit 0 of SMF 0 - 23 00: No error 01: Crossloop 10: Simultaneity fault 11: One channel open after reset
000417 - 000440	Fault bit 1 of SMF 0 - 23
000441 - 000464	Fault bit 2 of SMF 0 - 23
000465 - 000488	Fault bit 3 of SMF 0 - 23
000489 - 000504	Retrigger Fault SOF 0 - 23
000505 - 000512	Cross Fault of Terminals 12 - 17
000513 - 000848	Reserved
000849 - 000860	Fault log

❶ When a Logic Level A block is automatically created as a Pass Through, the block does not occupy memory and cannot be read over Modbus. This can be viewed in the CCW as a block with no title. Pass Through blocks in Logic Level B can be read over Modbus.

Figure 104 - (Non)Readable Pass Through Blocks

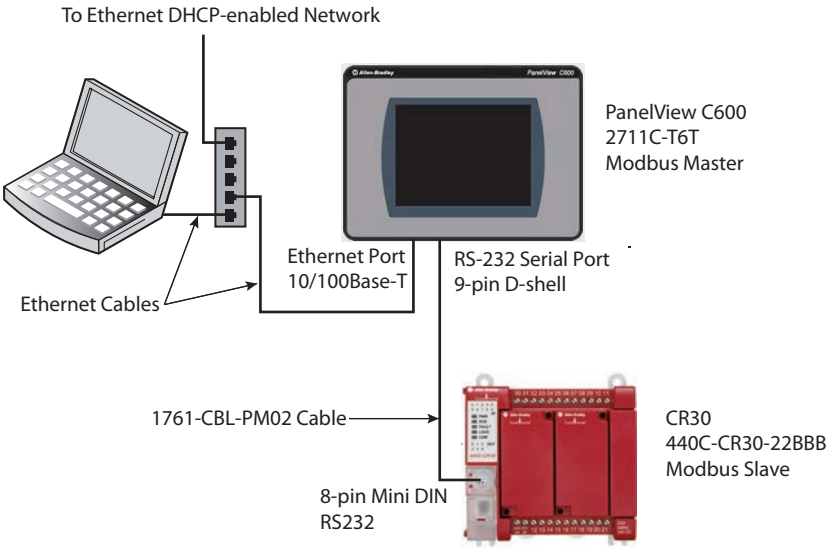


Example Architectures

Some examples of how the CR30 is used with Modbus are shown below.

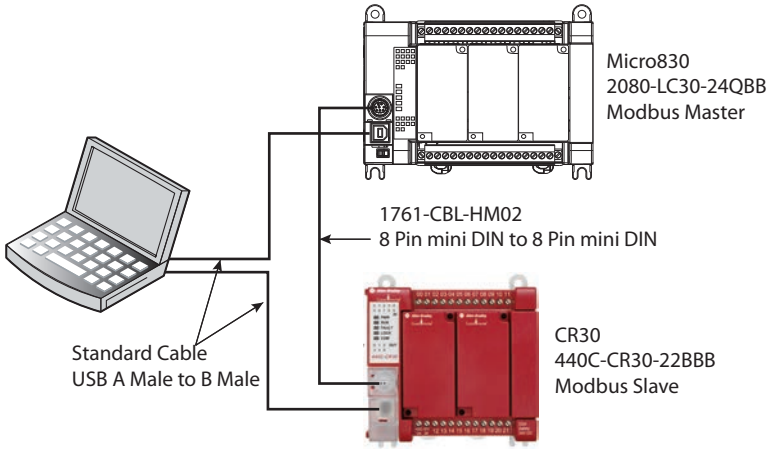
In the example below, a PanelView C600 is connected to the serial port of the CR30. The C600 is configured over its Ethernet port. The C600 can read status information from the CR30 and can send reset and restart signals to the CR30.

Figure 105 - Modbus RTU Communications — PanelView C600



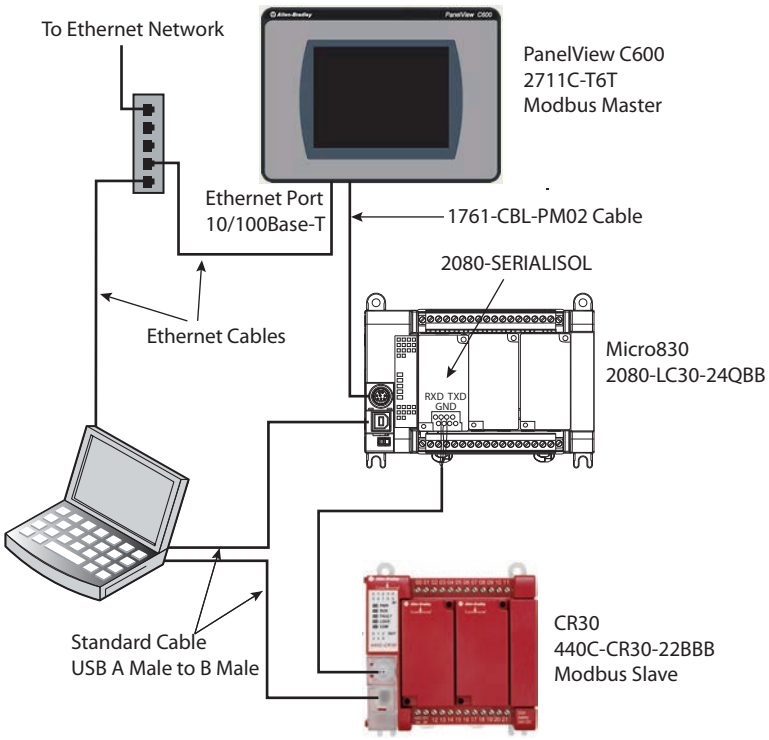
In this example, a Micro830 is connected to the CR30 by the 8-pin DIN serial port connections. The Micro830 can read/use status information from the CR30 and can send reset and restart signals to the CR30.

Figure 106 - Modbus RTU Communications — Micro830



In the example below, a PanelView C600 is connector the serial port of the Micro830 and the Micro830 is connected to the CR30 through a SERIALISOL plug-in module. The Micro830 can read/use status information from the CR30 and can send reset and restart signals to the CR30.

Figure 107 - Modbus RTU Communications — PanelView C600 & Micro830



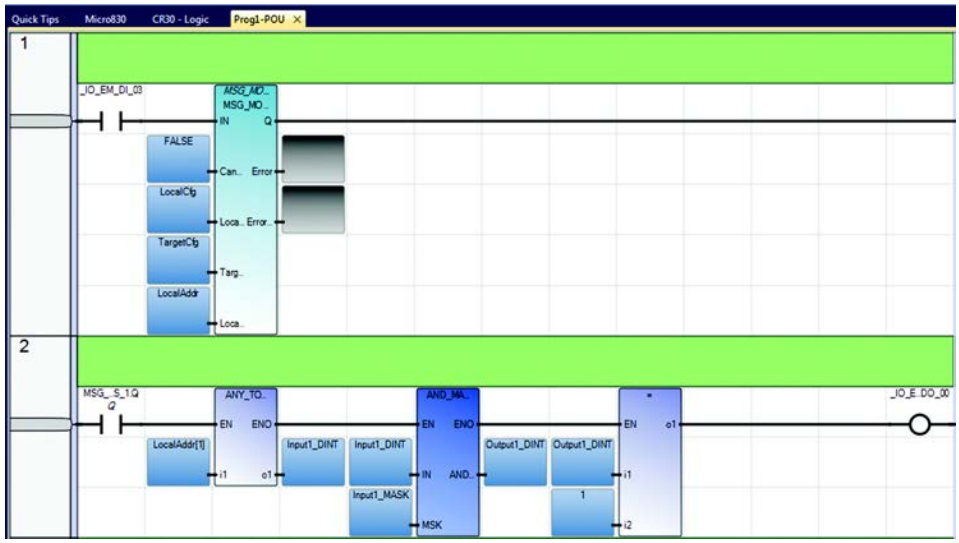
Reading CR30 Status

In the Micro 800 family, the Msg_Modbus block must be used.

In the example ladder diagram below, a Micro830 reads the status of the first five input wiring terminals of the CR30.

- Rung 1: When a push button, connected to terminal 03 of the Micro830, is pressed, the Micro830 sends a Modbus message to the CR30
- Rung 2: The format of the data in LocalAddr is a 'WORD'. The first block ANY_TO_DINT converts the 'WORD' to a 'DINT'. The second block compares the DINT to the value of 1 with an AND_MASK. The third block checks to see if the value is 1. If the value is 1, then the output terminal _IO_EM_DO_00 goes HI.

Figure 108 - Read Ladder Diagram



The user should set up local variables. In this example, they are labeled LocalCfg, TargetCfg, and LocalAddr.

- LocalCfg must be set up as a MODBUSLOCPARA data type. TargetCfg must be set up as a MODBUSTARPARA data type. LocalAddr must be set up as a MODBUSLOCADDR data type.
- TargetCfg.Addr - Select the first value from the Modbus Mapping table for the CR30. In this case, the initial value is set to 000273 (leading zeros must be included), which is mapped to terminal 00 of the CR30.
- TargetCfg.Node - Enter a value of 1. The CR30 is fixed at Node 1.
- LocalCfg.Channel - Select the serial port location. Enter a 2 if the embedded serial port is used. Enter a 5 to use the serial port in the fist plug-in slot.
- LocatCfg.TriggerType - Enter a 0 to have the block execute only once. Each time the push button connected to terminal _IO_EM-DI-00 is pressed, message will be sent once.
- LocalCfg.Cmd - Enter a 1 to instruct the block to read a 'coil' (which is mapped to the CR30).
- LocalCfg.ElementCnt - Enter a 5 read the status if 5 inputs (starting at 000273 and ending a 000277).

- LocalAddr - The results will be placed in LocalAddr. There is no need to make changes.

Figure 109 - Read Local Variables

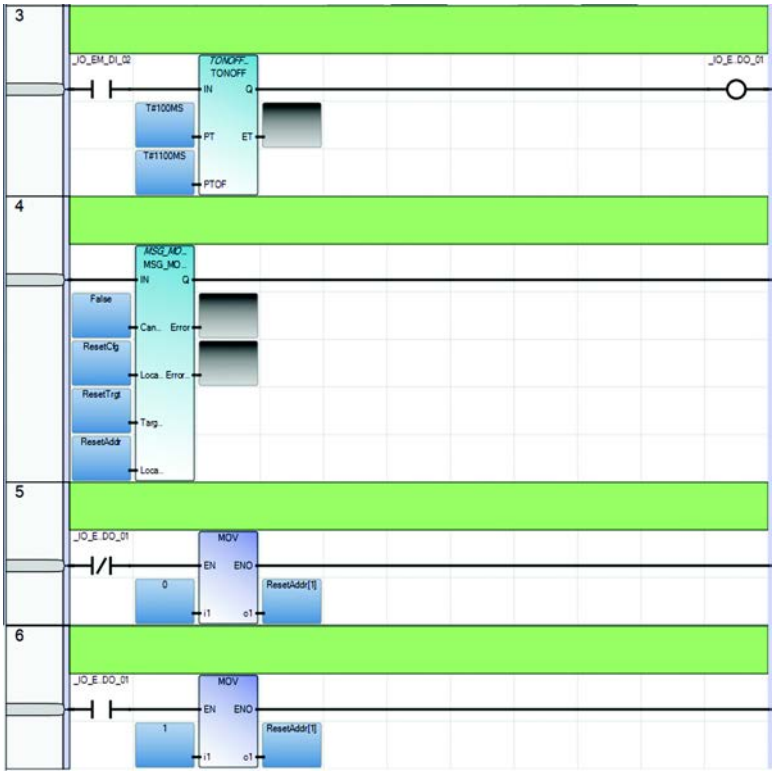
Name	Data Type	Dimension	String Size	Initial Value	Attribute
TargetCfg	MODBUSTARPARA			...	Read/Write
TargetCfg.Addr	UDINT			000273	Read/Write
TargetCfg.Node	USINT			1	Read/Write
LocalAddr	MODBUSLOCADDR			...	Read/Write
LocalCfg	MODBUSLOCPARA			...	Read/Write
LocalCfg.Channel	UINT			5	Read/Write
LocalCfg.TriggerType	USINT			0	Read/Write
LocalCfg.Cmd	USINT			1	Read/Write
LocalCfg.ElementCnt	UINT			5	Read/Write

Sending Reset to CR30

The Reset function must use a separate Modbus message block. Another constraint that must be considered is reset signal must be between 0.5...3 s long. In the example below, a momentary button is connected to embedded terminal _IO_EM_DI_02.

- Rung 3: The push button initiates a TONOFF timer. The timer is set for a 100 ms delay ON and a 1100 ms delay OFF. This provides a reset signal of 1 s.
- Rung 4: The Modbus message is sent with every scan of the ladder. The reset is executed because the reset value goes from 0 to 1 and back to 0 within the acceptable range of 0.5...3 s.
- Rung 5: When the TONOFF block goes LO, embedded output _IO_EM_DO_01 goes LO and moves the value of 0 into Reset Addr.
- Rung 6: When the TONOFF block goes HI, embedded output _IO_EM_DO_01 goes HI and moves the value of 1 into Reset Addr.

Figure 110 - Reset Ladder Diagram



The user should set up a second set of local variables. In this example, they are labeled ResetCfg, ResetTrgt and ResetAddr.

- ResetCfg must be set up as a MODBUSLOCPARA data type. ResetTrgt must be set up as a MODBUSTARPARA data type. ResetAddr must be set up as a MODBUSLOCADDR data type.
- ResetTrgt.Addr - Enter a value of 1, which is Modbus mapping of the CR30.
- ResetTrgt.Node - Enter a value of 1. The CR30 is fixed at Node 1.
- ResetCfg.Channel - Select the serial port location. Enter a 2 if the embedded serial port is used. Enter a 5 to use the serial port in the fist plug-in slot.
- ResetCfg.TriggerType - Enter a 1 to have the block execute every time the ladder is scanned
- LocalCfg.Cmd - Enter a 5 to instruct the block to write to a 'coil' (i.e., turn on an input of the CR30).
- ResetCfg.ElementCnt - Enter a 1 to write only 1 bit.
- ResetAddr - The results will be placed in LocalAddr. There is no need to make changes.

Figure 111 - Reset Local Variables

ResetTrgt		MODBUSTARPARA			...	Read/Write
	ResetTrgt.Addr	UDINT			1	Read/Write
	ResetTrgt.Node	USINT			1	Read/Write
ResetCfg		MODBUSLOCPARA			...	Read/Write
	ResetCfg.Channel	UINT			5	Read/Write
	ResetCfg.TriggerType	USINT			1	Read/Write
	ResetCfg.Cmd	USINT			5	Read/Write
	ResetCfg.ElementCnt	UINT			1	Read/Write
ResetAddr		MODBUSLOCADDR			...	Read/Write

Notes:

Troubleshooting

Faults fall into two categories:

- Recoverable
- Non-recoverable

Recoverable faults are those faults that can be corrected without having to cycle the power to the CR30. Non-recoverable faults require power cycling to recover after the fault is corrected.

Recoverable Faults

Recoverable faults can be cleared by eliminating the cause of the fault and cycling the inputs associated with the fault. The output that is connected to an input with that fault is switched off. The other outputs, which are not affected by the fault, will continue to work.

Examples of recoverable faults include:

- SMF Faults
- Cross loop
- Simultaneity Faults
- Reset button fault
- Muting: Synchronization time exceed
- Muting time exceeded
- Sequence fault

LEDs

Faults are indicated by the fault LED. If the fault LED is flashing red, a recoverable fault has occurred. If the Fault LED is solid red, a non-recoverable fault has occurred.

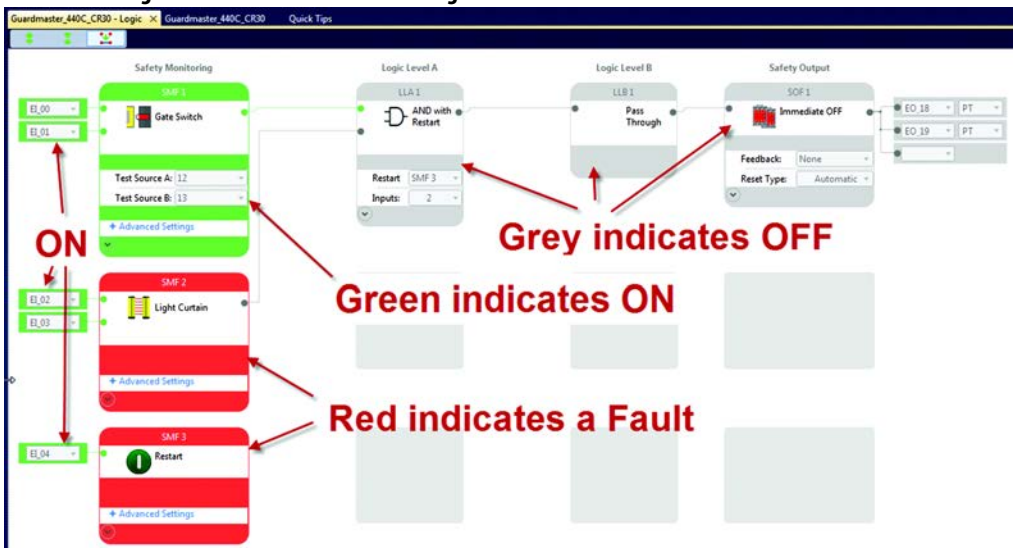
Figure 112 - Fault LED

Troubleshooting with the CCW

When connected to the CR30 through the USB port, the CCW Logic Editor monitors and displays the status of each terminal and block.

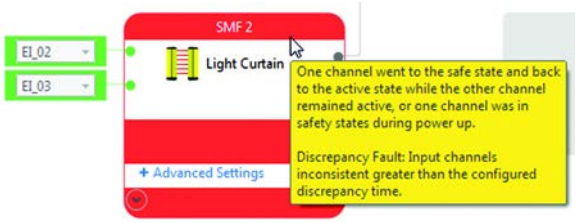
- Green shows an ON (HI) state.
- Red shows a Fault state (output is LO).
- Grey blocks are OFF (LO) state.

Figure 113 - Monitor Status with Logic Editor



Mouse over the red block, and the CCW displays an error message for 5 seconds. Move the mouse away and then back over the block to show the message again.

Figure 114 - Mouse Over to Show Error Message (in yellow box)


SMF 2
EI_02
EI_03
Light Curtain
+ Advanced Settings
One channel went to the safe state and back to the active state while the other channel remained active, or one channel was in safety states during power up.
Discrepancy Fault: Input channels inconsistent greater than the configured discrepancy time.

The type of fault is also shown in the top panel of the Project tab.

- For a recoverable fault, the Fault status field shows as 'Faulted' on the Safety Relay graphic view. When the device is in a faulted stated, the user can change the mode for recoverable faults. Mouse over recoverable faults does not provide additional information.
- For a non-recoverable fault, the Fault status field shows the fault type and status. The device switches to Program mode, which cannot be changed by the user. Mouse over the fault to get additional information.

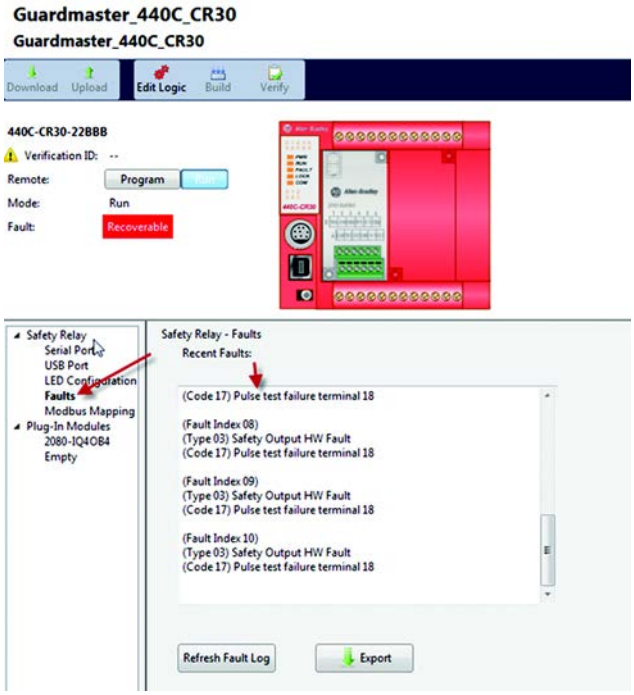
Figure 115 - Mouse Over Fault in Project Tab

To see a list of the recent faults, click on Faults in the Safety Tree.

The recent faults appear in the fault pane.

Click on the Export button to export the faults to a comma separated value (.csv) file. The default path for Win7 for saving the exported fault log file is the folder at C:\Users\<user name>\documents\CCW\Fault log.

Figure 116 - Recent Fault List



Troubleshooting with Modbus

Many faults can be reported to an HMI or PLC using Modbus. The table below shows a list of the Modbus addresses for faults.

Table 16 - Modbus Addresses for Faults

Modbus Address	Parameter
000265	Processor HW fault
000266	Safety Input HW fault
000267	Safety Output HW fault
000268	Power supply fault / Main transistor fault
000269	Communication fault
000270	Configuration fault (wrong revision, invalid configuration)
000271	Time out (Clock monitoring)
000272	Plug-in fault
000393 – 000416	Fault bit 0 of SMF 0 – 23
000417 – 000440	Fault bit 1 of SMF 0 – 23
000441 – 000464	Fault bit 2 of SMF 0 – 23
000465 – 000488	Fault bit 3 of SMF 0 - 23
000489 - 000504	Retrigger Fault SOF 0 - 23
000505 – 000512	Cross Fault of Terminals 12 - 17
000849 – 000860	Fault log

The table below shows the 'fault bit' message for the type of functions selected for the Safety Monitoring Function block.

Table 17 - Fault Messages for the SMF Type

SMF Type	Fault Bit 3	Fault Bit 2	Fault Bit 1	Fault Bit 0
1 Channel	Reserved	Reserved	Reserved	Input circuit shorted to 24V.
2 Channel, Two Hand Control	Reserved	The left and right buttons have been in an inconsistent state for longer than 500 ms.	Reserved	At least one circuit shorted to 24V or another input circuit.
Safety Mat	Reserved	Discrepancy Fault: Input channels inconsistent greater than the configured discrepancy time	One channel went to the safe state and back to the active state while the other channel remained active, or One channel went to the safe state upon power up.	At least one circuit shorted to 24V or another input circuit.
3 Channel	Reserved	Reserved	One channel went to the safe state upon power up.	At least one circuit shorted to 24V.
Reset	Reserved	Reserved	Reserved	A transition of the reset input from ON (1) to OFF (0) did not occur within 3,000ms.
Override	Reserved	Reserved	Reserved	At least one circuit shorted to 24V or another input circuit.

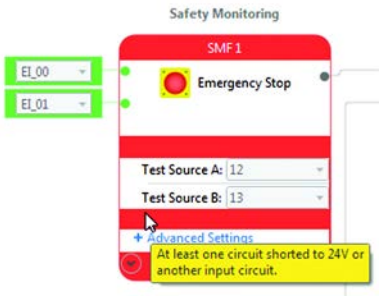
SMF Type	Fault Bit 3	Fault Bit 2	Fault Bit 1	Fault Bit 0
Restart	Reserved	Reserved	Reserved	A transition of the restart input from ON (1) to OFF (0) did not occur within 3,000ms.
Mute	Reserved	Muting sensor sequence fault.	The Light Curtain was muted for longer than the configured maximum mute time.	Too much time elapsed between Sensors being blocked.
Lack of Muting L-Type	Too much time elapsed between Sensor2 and Light Curtain2 being blocked.	Muting sensor sequence fault.	The Light Curtain was muted for longer than the configured maximum mute time.	Too much time elapsed between Sensor1 and Sensor2 being blocked.

Example Fault Analysis – Crossfault

Create a crossfault from Input Test Pulse A to Input Pulse Test B with the safety output ON.

- The Modbus address 000505 goes HI immediately, thereby showing that the fault was detected.
- About 4 seconds later, the fault is acted upon.
- Modbus address 000393 (Bit 0 of SMF1) goes HI.
- The Safety Output goes off.
- On the CCW Logic tab, the e-stop and gate inputs go off, and both logic blocks show red color.
- The CCW Project tab shows “Recoverable Fault”.

Figure 117 - Mouse Over E-Stop Block



Remove the fault

- The Modbus address 000505 goes LO immediately, thereby showing that the fault was removed.
- Modbus address 000393 (Bit 0 of SMF1) remains HI.
- On the CCW Logic tab, both the e-stop and gate logic blocks continue to show red color.
- The safety output remains off.

Cycle the e-stop.

- Modbus address 000393 (Bit 0 of SMF1) goes LO.
- On the CCW Logic tab, the e-stop block turns green, and the gate block remains red,

Cycle the gate.

- On the CCW Logic tab, the gate block turns green.

The safety system is back to an operating state and waiting for the reset button to be pressed.

Notes:

Specifications

General

Number of I/O	22
Dimensions	90 x 100 x 80 mm (3.54 x 3.94 x 3.15 in.)
Shipping weight, approx.	0.423 kg (0.933 lb)
Wire size	0.2…2.5 mm^2 (24…12 AWG) solid copper wire or 0.2…2.5 mm^2 (24…12 AWG) stranded copper wire rated @ 90 °C (194 °F) insulation max
Wiring category	2 – on signal ports 2 – on power ports Use this Conductor Category information for planning conductor routing. Refer to Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1.
Insulation stripping length	7 mm (0.28 in.)
Terminal screw torque	0.6 N•m (4.4 lb•in) max (using a 2.5 mm (0.10 in.) flat-blade screwdriver)
Input circuit type	24V DC source
Output circuit type	24V DC source
Power supply voltage range	20.4…26.4V DC UL Class 1, Div 2, PELV/SELV
Power consumption	5.28 W
I/O rating	Input 24V DC, 4 mA Output 24V DC, Class 2, 0.5 A per point
Enclosure type rating	IP20

Environmental

Temperature, operating	-5…+55 °C (23…131 °F)
Relative Humidity	90%
Vibration	10…55Hz, 0.35mm
Shock	10g, 16ms
Pollution level	2

Inputs

Number of Inputs	Up to 18 embedded 12 dedicated inputs 6 configurable as Inputs
Operating voltage range	20.4 . . .26.V DC
Off-state Voltage, max	5V DC
Off-state current, max	2mA DC
On-state voltage, max	26.4V DC
On-state voltage, min	11.0V DC
On-state current, min	?.? @ 20.4
On-state current, nominal	11.0mA @ 24V DC
On-state current, max	11.1mA @ 26.4V DC
Off Pulse accepted for OSSD setting without declaring the input as OFF	Min = 0 µs Max = 700 µs
Reverse Voltage Protection	Yes
Input Capacitance	10nF
Galvanic Isolation: I/O from Logic	No

Outputs

Number of outputs	Up to 10
Output Signals	Standard, OSSD and Single Wire Safety
Continuous output current	0.5 A
Aggregate current of outputs per device (Max)	5 A
Surge output current	1 A
Surge output current duration	5 ms
Residual voltage (drop from power supply), max	0.2V DC
Max load capacitance	200 nF / 20 mA load 100 nF / 10 mA load 22 nF without load
Off State Leakage Current (Max)	< 0.1 mA
Short Circuit Detection	Yes
Short Circuit Protection	Yes
Galvanic Isolation: I/O from Logic	No
Pulse Test Duration	≤700 µs
Pulse Test Period	≤13000 ms (less than 15 s)

Reaction Times

Safety Input	Automatic reset < 100 ms Manual monitored reset < 500 ms
Single wire safety input	
Safety Mats	

Recovery Times

Safety Output	Input cycle < 300 ms Power Cycle: Initialization time + 500 ms
Single wire safety output	
To trigger Inputs again	Response time as demand + reaction time + 100 ms

Response Times

Safety Input	<45 ms
Single Wire Safety Input	<45 ms
Safety Mats	<70 ms
Single Wire Safety Output	<60 ms

Notes:

Regulatory Approvals

Agency Certifications

- UL Listed Industrial Control Equipment, certified for US and Canada
- CE marked for all applicable directives
- C-Tick marked for all applicable acts
- CCC Mark
- S-Mark

Compliance to European Union Directives

This product has the CE mark and is approved for installation within the European Union and EEA regions. It has been designed and tested to meet the following directives.

Machine Safety Directive

This product is designed and tested to meet the European Council Directive 2006/42/EC on machinery and the following standards.

- IEC/EN 61508 - Functional safety of electrical/electronic/programmable electronic safety-related systems
- IEC/EN 62061 - Safety of machinery - Functional safety of safety-related electrical, electronic and programmable electronic control systems
- EN ISO 13849-1 - Safety of machinery -- Safety-related parts of control systems -- Part 1: General principles for design

This product is intended for use in an industrial environment.

SIL Rating

The CR30 meets the requirements of SIL CL 3 in accordance with IEC/EN 61508.

Table 18 - SIL Rating

Safety Integrity Level Claim Limit	3
PFD	10-4 ≤ PFD ≤ 10-3 (whole safety function)
PFH	10-8 h-1 ≤ PFH ≤ 10-7 h-1
Mode of operation	High demand mode
Safety related subsystems	Type B (use of programmable / complex components)
Hardware Fault Tolerance	HFT = 1 (two channel system)
Safe Failure Fraction	90…99%

Performance Level/Category

The performance Level of the safety function is dependent on the structure of all the devices that comprise the safety function.

The CR30 is capable of being used in safety systems meeting up to Category 4 and Performance Level PLe in accordance with ISO 13849-1.

Table 19 - Performance Level/Category

Category	Up to 4
Performance Level	Up to e

EMC Directive

This product is designed and tested to meet the European Council Directive 2004/108/EC on Electromagnetic Compatibility (EMC) and the following standards:

- EN 61000-6-4: Generic Standards - Emission Standard for Industrial Environments
- EN 61000-6-2: Generic Standards - Immunity for Industrial Environments

This product is intended for use in an industrial environment.

Rockwell Automation Support

Rockwell Automation provides technical information on the Web to assist you in using its products. At http://www.rockwellautomation.com/support you can find technical and application notes, sample code, and links to software service packs. You can also visit our Support Center at https://rockwellautomation.custhelp.com/ for software updates, support chats and forums, technical information, FAQs, and to sign up for product notification updates.

In addition, we offer multiple support programs for installation, configuration, and troubleshooting. For more information, contact your local distributor or Rockwell Automation representative, or visit http://www.rockwellautomation.com/services/online-phone.

Installation Assistance

If you experience a problem within the first 24 hours of installation, review the information that is contained in this manual. You can contact Customer Support for initial help in getting your product up and running.

United States or Canada	1.440.646.3434
Outside United States or Canada	Use the Worldwide Locator at http://www.rockwellautomation.com/rockwellautomation/support/overview.page, or contact your local Rockwell Automation representative.

New Product Satisfaction Return

Rockwell Automation tests all of its products to help ensure that they are fully operational when shipped from the manufacturing facility. However, if your product is not functioning and needs to be returned, follow these procedures.

United States	Contact your distributor. You must provide a Customer Support case number (call the phone number above to obtain one) to your distributor to complete the return process.
Outside United States	Please contact your local Rockwell Automation representative for the return procedure.

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Rockwell Otomasyon Ticaret A.Ş., Kar Plaza İş Merkezi E Blok Kat:6 34752 İçerenköy, İstanbul, Tel: +90 (216) 5698400

www.rockwellautomation.com

Power, Control and Information Solutions Headquarters

Americas: Rockwell Automation, 1201 South Second Street, Milwaukee, WI 53204-2496 USA, Tel: (1) 414.382.2000, Fax: (1) 414.382.4444
Europe/Middle East/Africa: Rockwell Automation NV, Pegasus Park, De Kleetlaan 12a, 1831 Diegem, Belgium, Tel: (32) 2 663 0600, Fax: (32) 2 663 0640
Asia Pacific: Rockwell Automation, Level 14, Core F, Cyberport 3, 100 Cyberport Road, Hong Kong, Tel: (852) 2887 4788, Fax: (852) 2508 1846

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